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ABSTRACT

This document is a quarterly report of the Educational Products Information Exchange (EPIE) Institute, a not-for-profit, consumer-supported agency. This issue is divided into two major sections, Microcomputer Courseware and Microprocessor Games. The first major section is divided into two parts. Part 1, Defining Effective Microcomputer Courseware contains the following: Introduction; The Evaluation Project; Exploiting Microcomputer Attributes in Courseware Design; State of the Art Report; and Glossary. Part 2, Courseware Analyses and Evaluations, has: Educational Micro Systems, Inc. (EMSI); Microsystems 80, Critical Reading; Milliken Math Sequences; Radio Shack K-8 Math Program; SRA Computer Drill and Instruction: Mathematics; and SRA Fact Track. The second major section contains parts 3 and 4, also subdivided. Part 3, the Educational Impact and Potential of Microprocessor Games: A Field Study, contains: Introduction; The Games Tested; The Study Design; and Findings. The final part, Product Descriptions, provides details on: Dataman, Math Master, Lil Genus, Little Professor, Quiz Kid, Speak and Spell, Spelling B, and Quiz Wiz microprocessor-based games. (MP)

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MICROCOMPUTER COURSEWARE/ MICROPROCESSOR GAMES

98/99m

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DEFINING EFFECTIVE MICROCOMPUTER COURSEWARE

INTRODUCTION

Approximately one out of every four public schools has at least one microcomputer or computer terminal that is used by students for instructional purposes. Of this total of 52,000 units, microcomputers outnumber the traditional terminals linked to a large central processor by more than three to two, with the proportion of microcomputers rapidly increasing (National Center for Education Statistics, 1981). The micros are attractive to schools because they are relatively inexpensive (between \$200 and \$6000 each) and can be purchased one unit at a time, they use a simple language (usually BASIC), and an entire self-contained unit can sit on a desktop.

Unhappily, the development and implementation of software packages has not been commensurate with the sales of the hardware. The production of "educational" software is a fractured cottage industry dominated by enterprising programmers, not educators. Instructional design concerns are only occasionally addressed in the single-concept tapes or disks. Even now that educational publishers, experienced in designing print instructional materials, are marketing large K-8 courseware packages, there have been no accepted criteria as to what comprises an effective instructional program.

This EPIE Report addresses the issue of what makes effective instructional software for the microcomputer. Included are a description of the ongoing evaluation project that EPIE is conducting, six comprehensive analyses and evaluations of large commercial courseware packages, and conclusions about the current state of the art.

This introduction focuses on the criteria that are considered essential in the design of courseware for the microcomputer. Also of concern are the qualities unique to the microcomputer which should be exploited to maximize its instructional potential. For instance, one of the most exciting features of the microcomputer for instruction is its capability to interact with the learner, to respond to

the learner's individual, immediate needs. Educators must also bear in mind that the microcomputer will not solve every instructional problem, nor is it most appropriately used as an elaborate workbook. By realizing the exact capabilities and limitations of the microcomputer, educators will become better consumers and users of the software. Once aware of what constitutes good instructional design and an effective program, consumers have an opportunity to directly shape the microcomputer courseware market by demanding high quality programs.

This report contains only the first of many courseware analyses and evaluations that will be forthcoming as a result of EPIE's cooperation with the Microcomputer Resource Center (MRC) at Teachers College, Columbia University. We will continue to focus on the large commercial courseware packages being marketed for school use and will also entertain suggestions of programs for analysis from our readers.

THE EVALUATION PROJECT

In the fall of 1980, EPIE Institute and the Microcomputer Resource Center began a joint project to analyze and evaluate instructional software for the microcomputer. The purpose of the project was to develop a systematic procedure for analyzing and evaluating educational software programs designed for school use. The software analysis instrument is adapted from EPIE's traditional instructional materials analysis instrument with its description of the developer's rationale, learning objectives, content, methods and activities, and the evaluation and management system built into the software. In addition it looks at specific instructional strategies which should be employed to facilitate instruction. In a departure for EPIE, this new instrument has an evaluative component, most apparent in the sections "Summary" and "Recommendations."

The seven project analysts came from two different

backgrounds: half of the group came from a computing/mathematics background and had technical programming expertise; the other half came from an instructional design background and had extensive experience in instructional materials development and analysis.

Each of the analysts individually used, analyzed, and evaluated each of the courseware packages included in this EPIE Report. In debriefing sessions the analysts then discussed and compared their findings. Each separate item on the analysis form (there are more than 80) was considered and variance among analysts was reduced. When disagreements persisted, this is noted in the final analysis.

A reliability test listed every item on the form and each analyst's ranked score. The reliability coefficient on the first analysis was 72%. By the sixth evaluation the coefficient was 96%.

EXPLOITING MICROCOMPUTER ATTRIBUTES IN COURSEWARE DESIGN

Curriculum Role

The microcomputer is more than just another medium of instruction. It has the potential to modify curriculum by absorbing the labor-intensive record-keeping responsibilities of individualized instruction and functioning as a surrogate "tutor." These capabilities can be applied in the classroom:

1. As supplementary adjuncts to the regular curriculum. Problem-solving, simulation, and drill and practice are examples of adjunct applications of the microcomputer.

2. As a "mainline" or basic course to teach a complete curriculum unit. No input from the teacher is needed and the microcomputer functions as a tutor teaching concepts and providing drill and practice on the concepts. Usually records are maintained and all instruction is managed by the computer.

3. As a management system only, providing student and class records on specific objectives and pinpointing each student's mastery level.

Other applications of courseware programs for the microcomputer include:

4. As a pre-programmed authoring device for teachers and students to create their own programs.
5. As a programming course.
6. As an assessment device whereby tests are given on the microcomputer and the student responses are immediately scored and reported to the teacher.

Mode of Interaction

How a courseware program for the microcomputer functions in the curriculum will be dependent upon the way in which the student interacts with the subject-matter and computer. The six types of interactions that can be used with the microcomputer are (see Glossary, page 10):

1. Drill and Practice
2. Tutorial
3. Gaming
4. Simulation
5. Problem Solving
6. Exploration.

Student Sequence

Basically, content is organized in a similar fashion across all media. Task analysis, natural unit sequencing, and chronological progressions through the content are common organizing methods. But how the student progresses through the content can be unique in microcomputer courseware since a linear path is neither necessary or desirable. Courseware can be designed to allow the student to choose his/her own sequence and follow a different route each pass through the content. An important student option is to be able to exit an activity and enter a new one, if desired. A book can be closed; a chapter can be skipped; a workbook page can be ignored. On the microcomputer, it is extremely frustrating to be forced through one activity after another with no choice but to continue. The student's only option then becomes one of turning the machine off and walking away.

Courseware can also be designed to allow the teacher to determine the sequence for a student, to individualize the sequence for each student. And, of course, the sequence can be fixed in the program, but this capitalizes least on the microcomputer's capabilities.

Instructional Text Format and Frame Display

There are two constraints on the quality of the text format and frame display on microcomputer monitors. Most video monitors used with microcomputers have a 250-line resolution, or about half the resolution quality we are accustomed to seeing in print materials. Reproducing the hard edges required by alphabets and numbers is therefore a technically difficult task for microcomputers unless they are programmed for rather large print. As the size of the print increases, however, the amount of memory available for other tasks is depleted. Because the print is inherently difficult to read, it is especially important that the formatting and frame display not add to the viewing difficulty. Lines of text must have space between them (amazingly, this is not always the case), long passages should be left to textbooks and magazines, and the screen should be completely clear before each new display rather than have frames fill up line by line.

Graphics

Graphics that are embedded in the instructional content (or are an integral part of the instruction) contribute to the learning process by presenting a visual model of the information to be learned. Graphic (as opposed to textual) representation of concepts takes advantage of a powerful capability of the microcomputer and is often easier for children to store in their memories. It can also facilitate recall by inducing them to actively construct their own mental representation of the information they are trying to learn.¹

¹Wittrock, M.C. "Learning and Memory." Paper presented at the annual meeting of the AERA, Boston, 1980.

Graphics used to enhance either the content or feedback can be helpful motivational devices but presume that the presentation is print-oriented. However, graphics used only to enhance (or relieve) a print presentation run the risk of distracting from the content and interfering with the program's intents.

Action on the Screen

Mindful of the above caveat and that there is little research on the role of graphic action, we viscerally react against courseware that denies the microcomputer's natural talent for color animation. Using it appropriately is a challenge courseware too often ignores.

Cues and Prompts

Just as a tutor can employ various techniques to help stimulate a student's recall, so can a good courseware program insure that cues for retrieval are available to the learner. These "cues" usually jog the memory and this contact gives rise to the feeling of recognition.²

Prompting is a form of learning guidance that uses cues which are eliminated or added in a step-by-step fashion. For example, if a student is trying to spell "trade", a prompt may be "_ _ _ de", the next one "_ _ a d e", and the next one "_ _ r a d e _". Designed into courseware, prompts are based on individual performance.

User Control

The whole notion of interactivity is realized when courseware allows the student to weave his or her own

²Gagne, R.M. *The Conditions of Learning*. N.Y.: Holt, Rinehart and Winston, 1977.

educational environment by controlling:

- the amount of time allowed for solving the problem (i.e., Can the user choose how many seconds each problem is presented so that he or she can quicken or slow down the pace?);
- the rate at which the display material is presented so that the user can read the information at his or her own pace;
- the choice of sequence so the user is not confined to a linear path;
- where entry into the program must begin;
- exiting an activity at any time;
- reviewing instructions;
- options available in the presentation such as "HELP", "HINT", "ESCAPE" keys.

Computer-Managed Instruction

If a courseware program is to capitalize on one of the most straight-forward capabilities of the microcomputer, record-keeping, it will have a sophisticated management system. In computer-managed instruction (CMI), the microcomputer should be able to: 1) collect and store data from the learning situation; 2) diagnose each student's status based upon performance; 3) prescribe activities to the student by moving a student forward to the next unit or assigning a student activities to eliminate a deficiency; 4) provide reports on student progress.³ In addition, the management system should be technically simple to use. Some systems are self-defeatingly difficult or cumbersome to use.

Feedback

Appropriate use of feedback is an important issue in evaluating courseware. The following should be considered:

³Baker, Frank: "Computer-Managed Instruction: A Context for Computer-Based Instruction." In Harold F. O'Neil, Jr. (ed.) *Computer-Based Instruction*. N.Y.: Academic Press, 1981.

1. Feedback should be non-threatening and not "yell" at the student for a wrong answer. A "friendly" courseware program is one that is interminably patient without penalizing the student.
2. Feedback should be immediate and inform the student whether the answer is correct or incorrect and what the correct response is. It is also helpful to explain why the response is wrong.
3. Feedback should not over-reinforce correct responses with elaborate praise every time the student answers correctly. For very young children or slower learners an abundance of positive feedback might be necessary at first, but an option should be available to fade out the constant feedback.
4. Feedback should remediate. A tutorial or explanation is often necessary to help correct the student's answers. The student should also have some way of matching his or her incorrect answer against the correct response.
5. Feedback should not reinforce wrong answers by providing a more rewarding graphic for a wrong response than for a correct response.
6. Feedback should be relevant for the user's age and level.

Records Stored on Magnetic Devices

The microcomputer can interface two forms of electronic storage devices--magnetic cassette tapes which use an audio tape recorder and digital magnetic disks ranging from small floppy disks to large hard disks used in one or more disk drives. The advantages of the magnetic disks far outweigh the higher price of a disk drive over the audiocassette recorder. The disk allows cumulative records for each student to be stored and immediately accessed at a future time. A student can complete a lesson, turn the machine off, and, later in the day or week the teacher can quickly retrieve the student's records. With cassettes no permanent records can be stored on the tape. When the machine is turned off all records are lost.

Content Designed To Be Altered

This feature is not widely utilized but has great potential for customizing programs to curriculum.

Random Generation

Random generation can be checked for, particularly in drill and practice courseware to assure that the student can repeat the same lesson over and over without encountering the same problems.

Packaging

First, check whether the component parts (either disks and/or cassettes) are packaged so that they do not literally fall out of their container (a common failing). Second, the disks and/or cassettes should be packaged and clearly labeled so that they can be distributed among many teachers, as these large programs are designed to be used across grade levels.

Teacher's Guide

The Teacher's Guide should contain: a) sufficient information to teach the teacher how to technically manipulate the program; b) classroom strategies for using the program; c) specific instructional activities to integrate the program into the curriculum. Also needed is a Student Guide to help the student access and technically manipulate the program. To alleviate fears and resistance, both guides should be extremely well organized, clearly stated, and provide a step-by-step approach.

STATE OF THE ART REPORT

After analyzing and evaluating most of the large commercial courseware packages on the market, it is possible to derive some conclusions about the state of the art of courseware for the microcomputer.

- Most programs on the market are a drill and practice application for supplementary use in the classroom.
- Most of the large, computer-managed packages are arithmetic programs.
- Most of the programs specify intended users but many recommend too wide an audience.
- No large courseware package is available for high school.
- The major emphasis of the programs' rationales is to develop skills in a particular area.
- The major emphasis of the programs' objectives is recall of previously learned facts.
- Most of the programs' objectives do not include higher order skills such as comprehension, application, analysis, synthesis, and evaluation.
- Scope of the content material is appropriate for learning levels of intended users in all programs except one. The range or depth of coverage of the content is adequate to achieve the program's intents in all but two of the programs.
- Few pre-instructional strategies are used to help orient the student to the content. Most of the programs don't even use a title at the beginning of each unit in the program.
- About 50% of the programs format the instructional text adequately. Sentence structure is a problem in half the programs.
- Few programs teach concepts and the only one that attempts to does not use any systematic method based on research for teaching of concepts.
- Rarely are graphics embedded in the instructional content. When used, graphics tend to be used to enhance either the instructional content or feedback.
- All the programs contain a Teacher's Guide. All the Teacher's Guides provide enough information to familiarize teachers with the technical use of the programs and with very general classroom strategies. None of them provide lesson plans or specific

activities to integrate the programs into the curriculum (although one program has a supplementary guide which does this).

- Most of the programs grant the user control in only two areas: 1) over the rate of display and 2) over exiting an activity at any time.
- All programs use feedback after both correct and incorrect responses.
- Most of the feedback responses do NOT remediate the wrong answer. Only one program informs why the response is wrong, although they all inform what the correct response is.
- 50% of the programs use diagnostic management (i.e., vary the level of difficulty as a result of performance).
- Half of the programs can store cumulative records for future retrieval. Most include printed sheets in the Teacher's Guide for manual record-storing.

Because elementary-level drill and practice arithmetic programs are relatively straight-forward to develop, all the major publishing companies have started in this area. This early emphasis tends to stereotype the microcomputer in the role of a drill and practice tool, one of the lowest levels it can operate on.

There is a great demand for programs which teach critical thinking skills, problem-solving techniques, and higher order skills such as application and synthesis of concepts. There is also a need to provide courseware for older students.

Two programs right now have a sophisticated management system which can handle storage of classroom data, individualize instruction, and provide detailed reports on student progress. However, both of them are technically cumbersome and somewhat difficult to access. As the market explores this new technology and as the memory capability increases, the management systems should improve.

The whole concept of interactivity has yet to be adequately explored.

Publishers must address the issue of integrating the microcomputer into the curriculum and the whole instructional environment.

You, as consumers, have the chance to affect the microcomputer market by becoming more aware of what constitutes good courseware. EPIE encourages you to use these analyses and evaluation guidelines in your courseware selection process. The upcoming *EPIE Equipment Report 98/99e: Microcomputer Hardware and Interactive Systems* complements this report and will help you become more aware of the capabilities and limitations of the microcomputer itself.

Please Note:

All six courseware packages have been evaluated with the same instrument. As a result, sometimes evaluations note that a particular feature, such as pre-testing, is not present in a program. This is not necessarily to suggest that such an absence is a fault in the material. Pre-tests, for example may not be important in a given program or may not be important in your own priorities for a courseware package. The evaluation instrument allows for direct comparability of programs. You must set your own priorities.

GLOSSARY

General Definitions

Computer-Assisted Instruction (CAI): An interaction between a student-controlled display and a response-entry device for the purpose of achieving educational outcomes.

Hardware: Equipment, including computers, disk drives, cassette players, cables, monitors.

Software: Computer programs and data, including application programs, operating systems, and languages.

Courseware: The software and all the supplementary print materials that constitute a complete course of study. Thus, a courseware package might include a magnetic tape or floppy disk and also a videotape, a set of microfiche cards, and a set of printed materials.

Microcomputer: Refers to a computer that costs roughly \$200 to \$6000 with the major computational capabilities concentrated in one electronic component called a "chip." Generally, it can not only do computations but can also communicate with terminals and store relatively large quantities of data. The functional components are the same as a larger computer system, which includes: input, memory, output, and central processing unit (CPU). Memory usually ranges from 4K (enough space to store about 4,000 characters) to 64K (about 64,000 characters). The commonly available language is BASIC.

Curriculum Role

Supplementary/Adjunct: Those applications of computers used by teachers as supplements to their regularly scheduled courses. Problem solving, simulation, games, and drill and practice are all examples of adjunct applications of the computer.

Basic Course/Mainline: Those applications of computers wherein a complete course is taught to students via the computer.

Management Only: An application where only the management of instruction is handled by the computer. It provides automated data

collection, data processing, and reporting capability to cope with the demands of individualized instruction. No instructional mode.

Mode of Instruction

Drill and Practice: Designed to supplement regular instruction elsewhere by providing a means by which concepts presented and developed in the classroom can be practiced and refined at the computer.

Tutorial: Intended to stand alone as an instructional entity; teaches rules and concepts embodied in the subject matter and evaluates the student's comprehension of these concepts.

Game: A situation where students have to know certain facts, perform certain skills, or demonstrate mastery of certain concepts; winning depends upon mastery of these cognitive skills.

Simulation: The dynamic execution or manipulation of a model of some object system so that the student can interact with and become part of that simulated reality.

Problem-Solving: The finding of solutions to novel problems that should be carefully distinguished from the routine substitution of numerical values in mathematical expressions of the same type--a kind of "drill." It involves the combining of previously learned rules into a new higher-order rule, which "solves" the problem and generalizes to an entire class of stimulus situations embodying other problems of the same type.

Exploratory Mode: A higher-order approach synthesizing many problem-solving skills into one creative endeavor; unstructured and exploratory in its methodology.

Intents The rationale, the goals, and the objectives of the intended instruction.

Behavioral Objective: A complete behavioral objective indicates:
1) what the student should be able to do in terms of a behavior,
2) the conditions under which the behavior is to occur, and
3) an acceptable standard of performance for the behavior. An

example is: Given 20 addition problems on the microcomputer that use single-digit numbers and have no carrying, the student will be able to solve them with 95% accuracy.

Higher Order Skills: The work of Bloom (1956) has attempted to arrange behavioral objectives along a continuum from simple to complex, forming a taxonomy of educational objectives. As the taxonomy is organized, it contains six major classes in which objectives can be expressed, ranging from the simplest rote-recall level to the highest level of evaluating theories. This taxonomy has been most useful to educators in helping them assess the level at which a program's objectives are located, whether most objectives fall at the lowest level of recall or toward the higher order skills of comprehension, application, analysis, synthesis, and evaluation.

Contents The scope and sequence of the subject matter to be included and the learning activities to be presented.

Scope: The width of the total subject matter or skills to be introduced, or covered, in pursuit of goals and objectives; all the topics to be covered.

Range: The extent or depth of coverage of each topic.

Linear Sequence: Student sequence through the content material has predetermined starting and ending points. The student has no choice over the sequence as it is totally controlled by the program and is usually a straight, fixed path.

Non-Linear Sequence: The student can control the sequence to some extent, and sequence through the content is not fixed by the program in a straight path; there is opportunity to explore the content in unique ways.

Advanced Organizers: Designed to provide a conceptual framework that students can use to clarify the task ahead. Based upon the work of Ausubel, advanced organizers emphasize the process of learning or the context in which the learner interacts with the subject matter, while other pre-instructional strategies concentrate on the product or subject matter content.

Cues/Prompts: Events which provide cues for the enhancement of recall. A form of learning guidance in which the cues are eliminated in a step-by-step fashion. Example: If "trap" is the correct response, a succession of prompts to enhance recall might be " _ _ _ p." " _ _ ap," and " _ rap."

Methodology The teaching/learning transactions or methods which are to be employed in an instructional material.

Branching: The ability of the computer to vary the level of difficulty as a result of student performance. For example, if a student answers three questions wrong the computer can automatically branch down to an easier level.

Random Generation: The ability of the computer to generate data randomly. For example, each time a set of addition problems is given, the computer will randomly display them so that the student will never get the same problems in the exact same order each time he/she goes through the exercise.

Means of Evaluation The approaches to assessment and evaluation of learning outcomes which are provided or at least suggested in an instructional material.

Computer-Managed Instruction (CMI): A total computer system designed to facilitate management of individualized instruction. The system provides: 1) data collection; 2) diagnosis of the student's performance; 3) prescription by varying the level of difficulty as a result of performance; and 4) reports of the student's progress. An instructional mode is included in this system.

Feedback: The message or compound statement which follows the response made by the learner.

Congruence The "fit" between the four constructs (Intents, Contents, Methodology, and Means of Evaluation) so that the material is tight and well-designed. For example, does the scope of the contents fulfill the rationale offered by the developer? Do the components of the evaluation system dependably assess whether the learner has realized the objectives? If each construct mutually supports and facilitates the other three constructs then there is congruence. If one construct is lacking or weak in one area, then congruence in that particular construct is missing.

Educational Micro Systems, Inc. (EMSI)

Publisher: EDUCATIONAL MICRO SYSTEMS, INC. (EMSI)
P.O. Box 471
Chester, N.J. 07930

Copyright: 1980

Microcomputer: TRS-80II, 16K
Apple II PLUS, 48K 3.3 DOS (disk only \$109.95)

Cost: \$139.95

Components:

TITLE	MEDIUM	TEACHER'S MANUAL
Whole Number Addition	1 cassette	1 for Total Program
Whole Number Subtraction	1 cassette	
Whole Number Multiplication	1 cassette	
Whole Number Division	1 cassette	
Fractions and Mixed Numbers	1 cassette	
Metric/English Conversion	1 cassette	
Logic/Deduction	1 cassette	

Subject Area: Mathematics

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation
Gaming (for Logic/Deduction tape only)

Intended Users: Not specified in the program but it is meant to be used for all grade levels. Analysts feel that the program could be used in grades K-12.

Learner Entry Competencies: Basic competencies in the processes of computation are required but this is not specified in the program.

INTENTS

Developer's Rationale: "To provide a powerful tool for computational skills; to shorten the period of time from initial awareness of a concept to mastery of related computational skill objectives." Analysts inferred that the rationale was to provide teacher with options for designing lessons for individual students.

Learner Goals/Objectives: No goals or objectives are stated in the Teacher's Guide or program; it can be inferred that the teacher is meant to choose his/her own from an "objective menu" displayed at the beginning of each tape.

Inferred goals/objectives:

- Application of specific skills
- Recall of specific facts

Instructional Strategies: No distinct strategy using Intents is employed to facilitate learning.

- Objectives are not stated.
- Objectives do not stress any higher order skills other than recall.
- Learners are not informed of the objectives.

CONTENTS

Scope: Scope of the content material is fairly comprehensive, covering: whole number addition, subtraction, multiplication, division; operations with fractions, logic, and conversion from metric to standard form.

- Range is adequate to achieve program goals/objectives.
- Scope is teacher-controlled based upon entry levels of intended users.

Sequence: The program is designed for the teacher to choose the specific tape and to sequence the material within that tape. The teacher must choose for each student the number of problems to be practiced, the number of digits within each number, the size of the numbers to be used, and many other options.

Entry into and out of an activity can be varied by the teacher and by the user. The student can exit an activity at any time by pressing "Shift Q".

Pre-Instructional Strategies:

- Overviews are presented before a student starts the sequence.
- A clear and concise title is presented at the beginning of each sequence.

Instructional Strategies:

- Information is formatted for easy reading most of the time.
- Short concise sentences are used most of the time.
- Vocabulary is appropriate depending on the age of the user. Younger children might have problems with some of the terms such as "subtrahend", "minuend", "dividend", "divisor", "multiplier", and other basic mathematics vocabulary words.
- The program never uses examples or nonexamples to teach a concept.
- Practice in varied contexts is not provided.
- Graphics are used only when a rocket goes off during feedback, which is teacher-controlled.
- Cues and/or prompts are controlled by the mode the teacher chooses.
- Action occurs on the screen only during feedback when the rocket goes off.

METHODOLOGY

Teacher/Student Use: Each program contains a number of options which the teacher must choose to determine the parameters of a lesson for a particular student. For example, in the addition sequence the teacher must select the following general program options: the number of addends each problem will have, the number of problems the session will have, and whether the program will operate in practice or test mode. Once the specific mode is chosen a series of additional options are provided for the teacher, such as type of feedback and type of rewards that the student will receive. After the general options are selected, the screen clears and the Objective Menu is displayed, from which the teacher must choose different combinations of codes to determine the type of problems that the lesson will contain. By selecting different combinations of objective codes, it is possible to generate practice and test sessions for virtually any type of problem.

Once the option review is accepted, the screen clears, and student directions are displayed. It is at this point that the student is to begin the lesson.

Teacher Guidance: Teacher training on use of the program in the classroom is not mentioned and although detailed instructions on how to operate each tape are provided, there is little mention of how to implement the program into the curriculum. The Teacher's Manual contains one section for each tape which specifies the different options a teacher may choose, explains how to start a student session, and describes the various components of each cassette-tape sequence. Teachers receive no guidance in identifying and matching student needs with program options.

Instructional Strategies:

- Instructions are clear on the addition, subtraction, multiplication, and division tapes. On the Logic/Deduction and Fractions and Mixed Numbers tapes, the instructions are often confusing and overly long. Some of the menus and options are also confusing. For the most part, instructions are written for the teacher and not the student.
- The program includes the option for the user to skip the instructions.
- Quite a bit of user control is available within each tape, most designed for teachers rather than students.

MEANS OF EVALUATION

Management System/Tests: To help the teacher organize, plan and assess the objectives chosen for each student, an Individual Student Progress Report form is provided in the Teacher's Manual. A copy of

this form must be made for each student. On the form the teacher lists each objective for the student and records the mastery score and date.

The program also includes a teacher-selected test mode option on many of the tapes. This mode allows the student to progress through the sequence without any feedback. The results can be used as a pretest, diagnostic test or mastery test.

After the student has completed all the problems in any of the modes, the computer will automatically display the number of problems correct and number of problems incorrect that the student attempted for that segment. The teacher is to record immediately these results on the Individual Progress Report and may then request a more detailed summary to appear on the screen, called a Session Analysis. This analysis provides more specific information about the session, such as the number of times the student pressed the help key and the number of incorrect responses entered while solving the problem (whether subsequently corrected or not) and in the final answer. The coding of this analysis is complex and a detailed description of how to interpret it is provided in the Teacher's Manual.

Unfortunately both the practice results displayed at the end of a session and the Session Analysis are not retained in the computer's memory and therefore are not accessible to the teacher for retrieval at a later time. If a teacher fails to look at these records before the computer is turned off or the student branches to another frame, all such records are lost. Furthermore, if a student does not master a teacher-chosen objective, there are no built-in branching procedures which would require further instruction in the areas of difficulty. The tests and remediation are totally optional and dependent upon the teacher's ability to sequence and recycle a student through the material.

Instructional Strategies:

- Feedback is used after both correct and incorrect responses except in the test mode, when no feedback is given.
- Feedback explains why the response is wrong and what the correct response is if a teacher chooses the practice mode option.
- The feedback responses are not varied from activity to activity or within each activity. The teacher has two options for providing feedback: a verbal response of "very good" after each correct response; or a rocket shot whereby an animated rocket will cross the screen. If the student's answer is correct and completed before the rocket moves off the screen, the student can "shoot it down" by pressing the space bar. If the student succeeds in doing this, the rocket is blown up and "GOOD SHOT" is displayed.
- The management system uses percentile management to track a student's performance (i.e., It keeps track of percentage

correct and incorrect. It does NOT use diagnostic management, which varies instruction as a result of performance.). • Records are formatted for easy reading. • Records are not easily accessible by the teacher; available only after an activity is completed. • Cumulative records for each student are not stored in memory for future retrieval but may be stored on copies of a form that is provided in the Teacher's Manual.	SUMMARY In summary the program was seen as being useful in classrooms with students who need basic drill and practice on mathematical computations. The Addition, Subtraction, Multiplication and Division programs were seen to be helpful and fairly well-designed. In contrast, the Fractions and Mixed Numbers, Metric/English Conversion, and Logic and Deduction tapes were not seen as being as useful to teachers. The Logic and Deduction tape was difficult to follow with the directions being overly long and confusing. It also seemed to be "tacked onto" the rest of the program by being thematically inappropriate when looking at the program as a curriculum package. The program was also seen as being very good for giving practice and testing to students. The Analysis Interpretation allowed the teacher and student to see where the errors were located and to determine whether the student learned from his/her errors. The help mode was also very helpful to those who were insecure with the basic rules. Unfortunately it was not used in programs other than the addition and subtraction tapes, probably due to memory restrictions. The basic problem of this program arose from the complex and time-consuming methodology required to utilize it correctly. It would require a great deal of time, patience and knowledge on the part of the teacher to sit down and choose the objectives and options for each student before the lesson began. The teacher would have to take a lot of time to develop the objectives and to record each student's results once the lesson was complete. This process would seemingly demand teacher-training which is not provided or mentioned. Furthermore, the tapes are not organized in a consistent fashion across the different segments and therefore the quality and design of some tapes is seemingly better than other tapes.
INSTRUCTIONAL DESIGN CONGRUENCE <u>Congruence:</u> This program does not have stated objectives; the teacher must select them while setting up each lesson for each student and then record each student's performance on them on the Individual Progress Reports. If a teacher succeeds in selecting the correct objectives for each student, manages to organize and sequence the content appropriately before each lesson, determines how to use the program "flexibly" by choosing suitable options, and records the practice and test results immediately (before they are lost) on the progress report, then the program can have tight internal congruence. But if the teacher fails to achieve any one of these tasks, the program will not be used correctly and will lack internal congruence.	RECOMMENDATIONS • Although this program is called an "Arithmetic Series by Teaching Objective," no objectives are provided. A written list of objectives would facilitate the teaching process and help save time for a teacher. It might also make the program a bit easier to utilize. • The author's intention was to have a lot of flexibility. Unfortunately ease of use was sacrificed as it takes too long to get through all the instructions. Perhaps simplifying the process would be helpful. • The relevance and appropriateness of the rocket shot to the purpose of the program is questionable. It takes up memory that could be used in other ways.
USE CONSIDERATIONS <u>Technical Consideration:</u> • No audio output is used. • Frame display is often cluttered and not formatted for easy reading, especially in the directions for the logic sequence. • Tapes are accurate in spelling, grammar, and word usage. • Packaging of the program is in a loose-leaf binder with the tapes attached inside the cover. If disseminated in a school, the tapes have no protection once out of the binder. • The writing style is appropriate for user population depending upon the age of the users. • Content is accurate and free of sexual, racial, and ethnic bias. • Design of the program is not organized in a consistent fashion across different segments (i.e., the structure of the Addition segment is totally different from the structure of the Logic/Deduction segment). <u>Development:</u> No documentation of development and/or research has been provided.	

- The management system requires a great deal of input and decision making before each child's use. If this could occur at an earlier time (and not when a teacher is probably involved with a classroom of students) and be stored in memory, the program would be easier to manage.
- The results of the practice and testing mode should also be stored in memory for easy retrieval by a teacher at a later time.
- There was no easy way to correct oneself once an error had been made. The computer tracked all errors instead of giving the student a chance to correct the mistake. This could be frustrating for a student as the Analysis Interpretation would pick up all errors whether they were due to a typographical error, incorrect estimate or actual mistake by the student. The only alternative was to turn off the computer and start over.
- Other frustrating instances occurred such as the student being unable to correct the last digit of a quotient without redoing the entire problem.

Microsystem 80, Critical Reading

Publisher: BORG-WARNER EDUCATIONAL SYSTEMS
600 W. University Drive
Arlington Heights, IL 60004

Author: Joseph M. Scandura

Copyright: 1980

Microcomputer: Apple II, 48K

Cost: \$750

Components:

TITLE	MEDIUM	TEACHER'S MANUAL
A	1 disk	1 for Total Program
B	1 disk	
C	1 disk	
D	1 disk	
E	1 disk	
F	1 disk	
G	1 disk	
H	1 disk	

Subject Area: Reading/Logic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Problem Review

Intended Users: Middle grades, junior high, senior high and adults, as stated in the Teacher's Manual. It is also specified that this program is designed to be used for those students taking the CAT/SAT exam.

Learner Entry Competencies: Students should be at or beyond a third grade reading level, as stated in the Teacher's Manual.

INTENTS

Developer's Rationale: "The Critical Reading program is designed to introduce a student to the basic rules of logic and to provide practice in reasoning skills which will aid in his/her overall comprehension of reading materials."

- To develop skills in a particular area.

Learner Objectives: Objectives are specified in the Teacher's Manual. Each objective is broken down into a Major Category, Subcategory, and Objective. An example:

Major Category: Rule for "Or" Elimination.

Subcategory: Making valid inferences.

Objective: Given a paragraph with one "or" situation, the student will be able to make a valid inference.

Major emphasis of objectives are:

- critical thinking skills

Instructional Strategies:

- Objectives are stated behaviorally.
- Objectives are stated in terms of the learner.
- Objectives include higher order skills such as comprehension, application, analysis, synthesis and evaluation.
- Learners are never informed of the specific objectives.

CONTENTS

Scope: Scope of the content material includes most of the rules for logic: the rule for "or" elimination, the rule for "all" elimination, conditional statements, and inductive reasoning.

- Analysts agreed that the range of the content material is not adequate to achieve program intents of providing practice in reasoning skills to aid in overall reading comprehension.
- Scope is appropriate for learning levels of intended users.

Sequence: The sequence of the content is designed to take a student through different rules of logic: "or" statements, "all" statements, conditional statements, paragraphs and conclusions, drawing conclusions, and determining missing premise. Each disk has four levels of instruction representing a progressively more difficult setting for use of the rule. The teacher initially places a student into the program. The student's lesson assignment is then automatically determined by the program on the basis of the pretest performance; the assignment is always the first lesson in the appropriate level. A student's progression through a lesson is determined by his/her performance on each lesson check.

Entry into and out of an activity is fixed by the program in a set sequence and once in a lesson, the student must continue through the activity. After the disk is in motion there is little that can be altered by the student to change the sequence except to press "reset" to escape from the whole program and start over again. The program will branch a student through a sequence based upon his/her performance.

- Content sequence is based upon natural units in rules of logic.
- Student sequence is dependent upon performance on pretests/progress tests.

Pre-Instructional Strategies:

- Pretests are used.
- Advanced organizers such as prequestions, overviews, and summaries are not used.
- Clear and concise title is not presented at the beginning of each segment.

Instructional Strategies:

- The information is often difficult to read. All the text is single spaced in the top half of the screen, which causes the text to be set off as a block of words.
- Short, concise sentences are used but often to the point of interfering with the flow of the text. Due to the fact that all the text is written on a third grade reading level, short simple sentences have been constructed within complex paragraphs. This causes it to be choppy.
- Vocabulary may sometimes be too far below the level of the intended user due to the third grade reading level.
- The program uses a number of examples to teach each rule.
- Practice of each rule in varied contexts is not provided. Different passages are given to teach each rule but the same format is used throughout. If an error is made, the same material is generated until the student gets it right.
- Graphics and diagrams are never used to enhance retention.
- Cues and/or prompts are used: after a wrong response, "Wrong, Think!" is displayed.
- No kind of action other than words ever appears on the screen.
- A demonstration of the exercise is given before a student attempts it. The pretest contains a "warm-up exercise" presented in the instructional mode.

METHODOLOGY

Teacher/Student Use: After a teacher initially places the student into the program (supposedly in Lesson Series A), a pretest is administered to determine a student's entry lesson. The lesson provides instruction in a basic rule of logical inference at the level of difficulty suitable for the individual student. The lessons are structured by having the students read a series of paragraphs using the logical inference rule. After the paragraph is read, the student must respond "True", "False", or "Unsure" to a list of statements. The student has up to two chances to respond with the correct answer. This is followed by either an explanation or reinforcement displayed on the screen.

Upon completion of a lesson, a review is administered whereby any statement that the student did not answer correctly on the first attempt is presented. The student is recycled through this material until all statements are answered correctly.

Once the student has worked through the lesson and review, a progress check is given to assess the student's understanding of the material. The score for the progress check is stored in the management system for that lesson series. At the completion of the progress check, a review is given which recycles the student through the material that was not correctly answered until all statements receive a correct

response. Completing the progress check ends the student's work for that session.

At the conclusion of each lesson series, a post-test is administered. The format and selections of this test are similar to the pretest.

Teacher Guidance: The basic methods for using the program are specified in the Teacher's Manual, which is fairly complete. The Teacher's Manual does provide enough information to familiarize the teacher with the technical use of the program, clearly describes how to use the program with students, is well-organized, and is easy to use. Actual specific strategies for integrating this program into a reading curriculum must be inferred and teacher training is not mentioned.

Instructional Strategies:

- Instructions in the program for the student could be more detailed and thorough although they are understandable.
- Very little user-control is available to the student: there is no choice through the sequence so the student must follow a fixed path; there is no control over where entry into the program must begin; there is no control over exiting an activity at any time except by turning the machine off; there is no control over reviewing instructions; and there are no options such as "HELP", "HINT", or "ESCAPE". The student does have control over the amount of time allowed to solve each problem.

MEANS OF EVALUATION

Management System/Tests: The management system of this program is fairly complete and quite easy for the teacher to use. Each lesson series contains its own management system which keeps records on all students working in that series. The tests have been built into the structure of each lesson so that a student will automatically branch from the pretest to the lesson to the progress test to the post-test. The student's ultimate route through the program is determined by his/her score on each of these tests.

The teacher has the records for each student available at any time by depressing certain keys on the computer. When the management system is entered, the teacher can select the particular class he/she is interested in and have a menu displayed which will list a variety of options. Each option is fully described in the Teacher's Manual.

Instructional Strategies:

- Feedback is used after both correct and incorrect responses during the instructional mode of the program.
- Feedback does explain why the response is wrong and what the correct response is.

- Feedback responses are not varied from activity to activity and differ from each other only by giving the correct answer with an explanation.
- Feedback uses printed words and an optional audio "beep" after each response; it never uses graphics.
- Feedback is used appropriately most of the time:
 - it is immediate
 - it does not over-reinforce the correct response
 - it remediates
 - at times, the wording could be less offensive and threatening. "Wrong. Think!" is displayed after the first wrong response and a less threatening approach would be useful.
- The management system uses both percentile management (which keeps track of percentage correct and incorrect) and diagnostic management (which varies the level of difficulty as a result of performance).
- The records are informative though they do not pinpoint areas of difficulty in the instructional sequence.
- Records are easily accessible by the teacher.
- Cumulative records for each student are stored in memory for future retrieval and can be stored on optional sheets printed out by the computer if a printer is available.

INSTRUCTIONAL DESIGN CONGRUENCE

Even though the program is a tight one, there was basic disagreement among the analysts over the extent of internal congruence in the four constructs. A basic flaw is that there is a mismatch between the rationale and objectives. The objectives stated in the program do not introduce students to all of the basic rules of logic and are not broad enough to provide adequate practice in reasoning skills that will aid in overall reading comprehension. With that mismatch in mind, the content itself is not broad enough in scope to achieve the program's basic intent, nor does the methodology support the intents. The methodology is basically a drill and practice application; it never really functions in the tutorial mode; therefore, it introduces the rules of logic to the student via drill only. The means of evaluation do measure the stated objectives but due to the initial mismatch, the rationale is never evaluated. The overall intent of the program is never achieved due to this mismatch.

USE CONSIDERATIONS

Technical Considerations:

- Graphics are never used in this program.
- An audio "beep" is an option that a teacher can utilize as a feedback device.
- The frame display is not formatted for easy reading; it uses

- only the top half of the screen and is difficult to read because of single spacing and short sentences.
- The program is technically easy to use.
- Random generation is never used in practice exercises.
- Tapes are accurate in spelling, grammar, and word usage.
- Packaging of the program is well-designed for component parts and does contain a Teacher's Manual.
- The writing style may not always be appropriate for its user population. Due to its third grade reading level, the style is often mechanical and may be too low for adults.
- Content is accurate and free of sexual, racial, and ethnic bias.
- The design of the program is organized in a consistent fashion across different segments (i.e., the structure of "A Lesson Series" is parallel to all the other disks).
- A separate brochure gives results of an empirical test which was carried out with the prototype materials. Every experimental subject scored better on the post-tests than on the pretest. This was not true of the control group.
- No documentation of development and learner verification and revision of the materials is provided.

SUMMARY STATEMENT

In general, Systems 80 Critical Reading is a tightly designed program that is easy to use and manage. Its sequence of pretest-lesson-progress check-posttest makes good use of the computer's capabilities and serves as a good model for diagnostic branching. The management system is technically easy to use and provides records of a student's progress that are readily accessible by the teacher.

What is lacking is an appeal mechanism which would help motivate the student to read the paragraphs and become actively involved in the learning process. Though this program is well-designed, it lacks any creative, dynamic effect and quickly becomes boring. Every rule is presented in the identical way and the context in which each concept is taught never varies.

In addition, the fact that ALL the questions can be answered with a True, False, or Unsure response makes it possible for a student to pass each unit by guessing and, perhaps, not understand any part of it. This calls into question whether the approach of analyzing and recalling the content of short paragraphs actually achieves the intents of the program: to help a student think more logically and read with more comprehension. It is also questionable whether this program could actually teach the logic needed to pass the CAT/SAT exam.

Setting the readability at the third grade level does minimize the chance of having reading problems interfere with the objective of the program, but it results in choppy, disjointed prose that is often difficult to read. This could compound the motivational problem with those very students who are having difficulties in the classroom. In addition, due to its formatting and spacing, the text is not presented clearly on the screen, which adds to the reading difficulty.

It must be concluded that although this is a technically slick program, it is questionable whether it will teach students logic and how to read with more comprehension.

RECOMMENDATIONS

- Double space all text on the screen; reformat the questions so that they are set apart from the paragraphs and easier to attend to.
- Reformat the way the screen is used; only the top half is actively utilized.
- Raise the readability level and thereby narrow the intended audience.
- Use more complex sentence structure. Try to eliminate the often choppy, disjointed prose within the paragraphs.
- Introduce some element of interest, excitement, stimulation. Be more imaginative in teaching the concepts by varying the context that is being used.
- During the review, a student must get every answer correct before going on. Identical material is generated and presented over and over, inferring that recall is the only skill required. Varying the material and the context each concept is presented in would help to ensure comprehension.
- The Teacher's Manual could contain a section on how the program could be integrated into the classroom curriculum. It would greatly help the program if introductory orientation lessons and debriefing exercises were included that covered the lesson concepts but in a different context.
- The instructional mode is not elaborate enough. Very little tutorial is included in the program to help teach each objective. It is inferred that the student will grasp the concepts by reading the paragraphs and answering the questions. This may be an erroneous assumption and a tutorial mode may be necessary.

Milliken Math Sequences

Publisher: MILLIKEN PUBLISHING COMPANY
1100 Research Boulevard
St. Louis, MO 63132

Copyright: 1980

Microcomputers: Apple II, 48K
TRS-80 Level II, 15K
Commodore Pet, 8K

Cost: Apple II (disks): \$450.00
TRS-80 and Commodore Pet (cassettes): \$200

Components:

GRADE LEVEL	TITLE	MEDIUM	TEACHER'S GUIDE
1	Number Readiness	1 disk	1 for Total Program
1-8	Addition	1 disk	
1-8	Subtraction	1 disk	
2-8	Multiplication	1 disk	
3-8	Division	1 disk	
1-8	Laws of Arithmetic	1 disk	
6-8	Integers	1 disk	
3-8	Fractions	1 disk	
4-8	Decimals	1 disk	
5-8	Percents	1 disk	
7-8	Equations	1 disk	
5-8	Measurement Formulas	1 disk	

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation

Intended Users: Grades 1-8, as stated in Teacher's Guide

Learner Entry Competencies: Basic competencies in the processes of computation need to be taught elsewhere.

INTENTS

Developer's Rationale: As stated in the Teacher's Guide: "This material correlates with concepts presented in most basic mathematics tests. The math sequences provide individual drill and practice for students in math operations that have already been introduced by the teacher."
o Develop skills in particular area
o Supplement other resources

Learner Objectives: No objectives are stated in the Teacher's Guide but progress through specific problem levels are specified in a detailed Scope and Sequence Chart in the Teacher's Guide for all sequences. An example of a problem level and the exercises that are taught in the level from the Number Readiness Sequence follows:
Problem Level: Associating a Set with its Number
Exercises: o numbers 1-5
o numbers 0-7.

Major emphasis of inferred objectives are:

- Application of specific skills
- Recall of specific facts

Instructional Strategies: No distinct strategy using Intents is employed to facilitate learning.

- Objectives are not stated behaviorally, though the Scope and Sequence chart does state them in terms of skills.
- Objectives are not stated in terms of the learner.
- Objectives predominately stress the skill of recall. In a few instances some exercises require the higher-order skill of comprehension.
- Learners are not informed of the objectives.

CONTENTS

Scope: Scope of the content material is fairly comprehensive, covering: number readiness, addition, subtraction, multiplication, division, laws of arithmetic, integers, fractions, decimals, percents, equations, and measurement formulas.

- Range of content material is adequate to achieve program's intents.
- Scope is appropriate for learning levels of intended users.

Sequence: As specified in the Teacher's Guide, each mathematical sequence contains exercises ranging from simple to complex which are divided into problem levels. When a student completes the minimum number of exercises presented at a particular level and achieves mastery, he/she advances to the next problem level. If the student misses three consecutive problems or his/her score falls below assigned failure level, the computer drops that student one problem level.

The program sequence is initially determined by the teacher, who must assign each student to a particular problem level, determine how many problems will be assigned at each level, and set the mastery and failure level for each assignment. Once these are established by the teacher, a student may access the specified sequence and be placed immediately into the assigned problem level. The student then works through the sequence at his/her own pace. By pressing the "escape" key, the student can exit an activity at any time and come back to the same assignment at a future date.

Sequence of content is based upon:

- Natural units in the subject-matter.
- Task analysis (i.e., breaking each sequence into parts and teaching progressively harder steps).

Pre-Instructional Strategies:

- Pretests are not used; initial placement into each sequence is made by the teacher.
- Advanced organizers such as pre-questions, overviews, or summaries are not used.
- A clear and concise title is presented at the beginning of each disk but no titles are given before each specific instructional sequence or problem level.

Instructional Strategies:

- Information is formatted for easy reading, though for the most part there is very little text.
- Sentences are very short and concise, often to the detriment of the program as the text and instructions become too abbreviated.
- Graphics in feedback is an option only a teacher can choose.
- Diagrams are rarely used except in the Measurement Formulas sequence and in the records of the Management System.
- Cues and prompts are used after the first wrong response with the computer telling the user that he/she is wrong. A second chance to answer the problem correctly is then given.
- Action occurs on the screen only during positive feedback when (optional) graphics are displayed.

METHODOLOGY

Teacher/Student Use: Before a student can progress through a sequence, the teacher must "initialize" each disk by entering the teacher's name, the password, and the class name. Once that is done a teacher can add students to the class and must give each student an assignment by specifying the problem level(s), determining how many problems should be given, and setting the mastery and failure level. A student can then access the sequence at any time as all that informa-

tion is stored in the memory. The student progresses through the assignment at his/her own pace and all records are retained in the computer's memory. The program continuously branches up to the next problem level if the student passes the specified mastery level, and branches down to the previous problem level if the student falls below the failure level or misses three consecutive problems. In this way, the student works through the specified assignment until it is complete. Each time the student exits the sequence, his/her records are displayed, showing how many problems were correct and incorrect for that lesson.

The basic methods for using the program are specified in the Teacher's Guide. Although the Teacher's Guide provides enough information to familiarize the teacher with the technical use of the program and provides a step-by-step approach to access each sequence, the overall methodology can be difficult to manage. If a teacher doesn't sit down and carefully read the Teacher's Guide before trying the program out, the Milliken Math Sequences will be confusing and extremely difficult to initially access. The key point is that the teacher must carefully follow the directions in the Teacher's Guide in order to manage the program effectively.

Teacher Guidance: Teacher training on use of the program in the classroom is not mentioned although detailed instructions on how to operate the program are provided. There is a brief overview of various strategies that can be employed to implement the program into the curriculum. A good Scope and Sequence chart provides additional help on integrating the program into the classroom.

Instructional Strategies:

- Instructions in the program for the student are often too short and therefore unclear. Since the instructions are kept to an absolute minimum, the student may find the program difficult to use until he/she has had some experience.
- Some user-control is available to the student within each sequence. To exit an activity the student can always press the "escape" key, which still allows him to view his progress on the screen. In addition, a student can occasionally choose different ways of solving a problem. For example, a student can choose whether or not to use regrouping when computing a problem or whether to solve a division problem using long or short division.

MEANS OF EVALUATION

Management System/Tests: The management system of this program is fairly comprehensive once the teacher learns how to use it. An especially strong feature is that once a disk has been "initialized," a menu is displayed which allows the teacher to make individual and class assignments, review individual and class performance, establish

performance levels for each student, and receive optional printed records of student performance.

The management system also provides a security system which keeps all teacher and student data confidential. Supplementary duplicating masters accompany the program and are intended as optional record-keeping materials.

Tests are not included as part of the program. Progress on each level constitutes a "test" and ultimately decides whether the student branches up or down the sequence. A teacher can easily check a student's progress by accessing the management system and requesting to review individual or class performance data. Records of each student's progress on specific assignments are displayed and provide information on the number of problems attempted, whether they were answered correctly or incorrectly, the performance level, and whether the student reached mastery at the specific problem level. A bar graph illustrates the student's movement through the levels for each assignment.

Though initially difficult to use, the management system is basically sound and provides the teacher with an effective means of individualizing instruction and quickly assessing whether mastery was achieved on each assignment.

Instructional Strategies:

- Feedback is used after both correct responses and incorrect responses.
- Feedback does not explain why the response is wrong but does show where the mistake is and then gives the correct answer.
- Correct feedback responses vary within each activity and vary from activity to activity. Incorrect feedback is always the same--a huge, aversive "X" flashing across the screen.
- Correct feedback can use either graphics or printed words depending upon the teacher's choice.
- The management system uses both percentile management (which keeps track of percentage correct and incorrect) and diagnostic management (which varies the level of difficulty as a result of performance).
- The records are informative although they do not pinpoint areas of difficulty in the instructional sequence.
- Records are easily accessible by the teacher once she/he learns how to use the program.
- Cumulative records for each student are stored in memory for future retrieval.

INSTRUCTIONAL DESIGN CONGRUENCE

Congruence: This program has good internal congruence with all four constructs being mutually supportive. Analysts unanimously agreed

that this was a tight drill and practice program.

USE CONSIDERATIONS

Technical Considerations:

- Graphics are not an intrinsic part of the instructional content, but when used in positive feedback they have clear resolution and are in color.
- Audio output is not used.
- Frame display is clear and formatted for easy reading.
- Once familiar with it, the program is technically easy to utilize in the computer. A teacher CANNOT bypass the Teacher's Guide.
- Random generation is always used in practice exercises. It is used frequently in corrective feedback and never used in negative feedback.
- Tapes are accurate in spelling and grammar. Some of the word usage is confusing due to the concise nature of the written text.
- Packaging of the program is well designed for the component parts and contains a Teacher's Guide.
- The writing style may be too advanced for the early grades.
- Content is accurate and free of sexual, racial and ethnic bias.
- Design of the program is organized in a consistent fashion across the different segments (i.e., the structure of the addition segment is parallel to the other segments in the program.

Development: No documentation of development and/or research has been provided.

SUMMARY

This program is generally seen as a good program which supports its overall intent of providing drill and practice for students in mathematical skills that have already been introduced by the teacher. The scope of the program is comprehensive and the sequence constantly builds on and reinforces those skills.

The management system is basically sound although it is not easily learned. A great deal of practice and pre-reading of the Teacher's Guide is necessary before a teacher can successfully utilize the program. Once it is mastered, the management system offers the teacher a great deal of flexibility in how the program can be utilized in the classroom - one of the program's strongest features. However, the records do not provide specific information on where students had trouble within a particular activity, nor do they provide any prescriptive information. The analysts also had difficulty with the

class assignment page and could not get it to work correctly.

Feedback is not used as appropriately as it could be. The negative feedback is too aversive and becomes painful to look at. This could become a problem with some students who are making a lot of errors. The positive feedback is repetitive and overdone. It becomes annoying to work through the problems and have a cute graphic figure appear on the screen after each correct answer. An alternate mode is available whereby verbal feedback can be used for students in the upper grades. (However, research has shown that positive feedback is unnecessary after every correct response and that feedback is most effective after incorrect responses only.)

For teachers who need drill and practice activities in the classroom, this program would do very well. It utilizes many of the unique aspects of the computer and provides a good supplement to the regular classroom teaching.

RECOMMENDATIONS

- The management system should be easier to access.
- The negative feedback is too aversive. The huge "X" is inappropriate.
- Many of the activities in the program and on the Scope and Sequence chart are not sequenced correctly, with more difficult concepts being introduced before easier ones. An example is the "greater than" and "lesser than" comparison, which is a very difficult concept for young children to understand.
- Sometimes the answer must be typed in backwards, which is a very unnatural method. An example is in horizontal addition of single digits where a two-digit sum must be entered from right to left.
- Movement from problem to problem is sometimes slow with too long a delay after the return key is hit.
- Placing the decimal point while in the middle of computing a division problem is confusing. An added problem is that the decimal point is too small.
- Many of the problems require no thinking on the part of the students, who could quickly learn to guess correctly. Examples are in the fraction sequence and the integer sequence whereby students can easily guess many of the answers rather than think through the problems.

Radio Shack K-8 Math Program

Publisher: TANDY CORPORATION
Fort Worth
Texas 76102

Copyright: 1980

Microcomputer: TRS-80 Model I Level II tape system (16K)
TRS-80 Model I Level II disk system (32K or 48K)
TRS-80 Model III tape system (16K)
TRS-80 Model III disk system (32K or 48K)

Cost: \$199.00

Components:

GRADE LEVEL	TITLE	MEDIUM	TEACHER'S MANUAL
Part I: Model I and III tape system			
K, 1st	Kindergarten and First Grade Lessons	1 cassette	1 for total program
2nd	Second Grade Lesson	1 cassette	
3rd	Third Grade Lesson	1 cassette	
Part II: Model I and III tape system			
1-8	Addition and Subtraction	1 cassette	
3-8	Multiplication and Division	1 cassette	
Also: Model I disk system		3 disks	
Model III disk system		1 disk	

Support Related Materials: K-8 Math Cross-Reference Guide coordinates individual K-8 Math Program lessons with specific pages in seven different math basals.

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and practice
Computation

Intended Users: Grades K-8 as stated in the Teacher's Manual

Learner Entry Competencies: Basic concepts in mathematics as specified in the Teacher's Manual.

INTENTS

Developer's Rationale: As stated in the Teacher's Manual: "The major purpose of the program is to supplement the existing mathematics curriculum by assisting the instructional process. The program is designed to assist you in the following three ways:

- 1) student placement;
- 2) skill building lessons;
- 3) tests."

Major emphasis of the rationale is to:

- Develop skills in a particular area
- Supplement other resources

Learner Objectives: Objectives are not stated as such but in Appendix I-A of the Teacher's Manual there are content summaries for each sequence. These could easily translate into objectives. An example from the First Grade Lesson Content Summaries is:

Lesson 4: Number range: 0-5

Activity: Basic addition facts to a maximum sum of 5, vertical format

Procedure: One ordered sequence of the basic facts to a maximum sum of 5, with 2 example problems worked for the student first.

Major emphasis of inferred objectives is:

- Recall of previously learned facts

Instructional Strategies: No distinct strategy using Intents is employed to facilitate learning:

- Objectives are not stated behaviorally.
- Objectives are not stated in terms of the learner.
- Objectives predominately stress the skill of recall. Few exercises require any higher order skill such as comprehension, application, analysis, synthesis or evaluation.
- Learners are not informed of the objectives.

CONTENTS

Scope: Scope of the content material covers the following topics: basic number recognition, addition, subtraction, multiplication, and division.

- Range of the content material might be adequate to achieve program's intents of providing supplementary practice in basic skills in the four functions, but content does not match curriculum in grades 6, 7, and 8 where geometry, measurement, ratio, proportion, decimals, and fractions are introduced and practiced.
- Scope is not appropriate for all intended users. The lower levels are confusing and difficult for kindergarten and first grade while there is not enough content covered in upper grades.

Sequence: The program includes a horizontal sequence (Part I), which follows a general school math curriculum for each grade level (K-3), and a vertical sequence (Part II), which contains skill building exercises for use in the appropriate grade level (1-8). In Part I,

K covers number concepts horizontally; 1st and 2nd grade covers number concepts, addition, and subtraction horizontally; 3rd grade covers addition, subtraction, multiplication, and division horizontally. In Part II, the placement mode determines a student's present skill level in each of the four basic functions of mathematics. There is vertical coverage of addition and subtraction for grades 1-8 and vertical coverage of multiplication and division for grades 3-8.

Student sequence through the total program is initially determined by the teacher in Part I and by the program placement test in Part II. Once in the program, the student works his/her way through the activities and is "promoted or demoted" according to his/her performance. Student entry into and out of an activity is controlled by the teacher, who must press the keys "R,T" to get results of the lesson before a student can move to the next lesson. The student may use this code to work through the program independently and/or to exit an activity at any time. Independent student control, however, may preclude close teacher monitoring of a student's progress.

Sequence of content is based upon:

- Natural units in the subject-matter
- Task analysis (i.e., breaking each sequence into parts and teaching progressively harder steps).

Pre-Instructional Strategies:

- Pretests are used in Part II to determine a student's skill level in the four basic functions of mathematics. Pretests not used in Part I, which covers the K-3 curriculum.
- Advanced organizers such as pre-questions, overviews, and summaries are not used.
- A clear and concise title is not presented at the beginning of each segment in the program.

Instructional Strategies:

- Information is formatted for easy reading.
- Labels or headings are not used to identify different kinds of information.
- There are no real sentences in the program except for short feedback statements.
- Vocabulary is appropriate for the user, although there is very little prose present.
- When used, graphics are sometimes embedded in the instructional content, especially in the K and 1st grade tapes which use graphics to teach the concepts. Sometimes graphics are used for enhancement with a smiley face as feedback in the lower grades.

- Graphics are used appropriately:
 - they are relevant for user's age and level
 - they are not distracting
 - they support the program's intents
- Cues and/or prompts are used after the wrong response. After the second wrong response, the answer flashes for one second and then disappears.
- No graphic movement other than words and numbers appears on the screen.
- In the lower grades an example of how to do the exercise is given. This example goes much too fast and a student does not get enough time to study it carefully, making it virtually useless.

METHODOLOGY

Teacher/Student Use: The teacher must initially choose the mode that the student is to work in from a menu that is displayed. In Part I, two operational modes are available: a) skill building lessons, or b) test mode. In Part II four options are available: a) student placement; b) skill building lessons; c) test mode; or d) an option to change lessons per session. After the mode is selected, the teacher writes in the student's name and chooses a lesson number. The student will then access the program in the mode the teacher has just chosen. Once the lesson is completed, a record of the student's progress is reported. The student cannot continue until the teacher sees the screen and presses the appropriate code of "R,T" (unless the student has been taught the code).

Teacher Guidance: The basic methods for using the program are specified in the Teacher's Manual. The manual does provide technical assistance on how to use the microcomputer and gives general suggestions on using the program, especially regarding the placement mode and promotion policy of the grade level programs. But no real guidance is provided on how the teacher could use the program in the classroom. There are no lesson plans, nor any specific instructional activities to integrate the program into the curriculum. Sequencing students through Parts I and II (which overlap in content a great deal) is not clearly specified. The supplementary *K-8 Cross-Reference Guide* does help to integrate the program into the curriculum and should be quite useful.

Instructional Strategies:

- There are no student instructions.
- The user can control:
 - rate that display material is presented in order to read information at own pace;
 - options available such as pressing keys for borrowing, carrying, and erasing errors.

The user cannot control: - amount of time allowed for solving the problem (i.e., choice of how many seconds each problem is presented); - sequence, so as not to be confined to linear path; - where entry into the program must begin; - exiting an activity at any time; - reviewing instructions.	• Cumulative records may be stored on printed sheets in the Teacher's Manual, if the teacher chooses.
MEANS OF EVALUATION	INSTRUCTIONAL DESIGN CONGRUENCE <u>Congruence:</u> This program has good internal congruence with all four constructs being mutually supportive. This is a tight drill and practice program.
<u>Management System/Tests:</u> The management system of this program is quite rudimentary and does not utilize the full capabilities of computer-managed instruction. Some diagnosis and prescription do occur with the student moving up upon successful completion of a lesson or down upon failure. Brief records are provided on the computer after a lesson is completed, but they are not stored on a magnetic device for future retrieval and disappear when the student moves on. A Student Record Sheet provided in the Teacher's Manual is to be duplicated and used to manually record each student's progress. Placement tests and mastery tests are provided and are options a teacher can choose when starting the program. <u>Instructional Strategies:</u> • Feedback is used after both correct and incorrect responses. • Feedback never explains why the response is wrong. • Feedback informs what the correct response is after two wrong attempts. • Feedback responses are varied from activity to activity, but never within an activity. Sometimes a smiley face appears, sometimes a reinforcer word such as "great" appears. • Feedback sometimes uses graphics and sometimes uses words, depending on grade level. • Feedback is used appropriately: - it is always immediate; - it does not over-reinforce correct responses; - it is relevant for user's age and level. - Feedback is not used appropriately: - it is threatening at times by "yelling" at the student if he/she doesn't answer quickly or correctly; - it never remediates. • Records are somewhat informative, although brief. They tell the teacher how many problems the student worked, how many of those were correct, the total percentage correct, and the student's average response time. • Records are accessible by the teacher only when the student completes the lesson. After that, the records disappear.	USE CONSIDERATIONS • Graphics have clear resolution, are not in color, and are presented clearly for maximum understanding. • Frame display is clear of clutter, formatted for easy reading, and cleared before each new display. • Program content is technically easy to utilize in the computer. • Random generation is always used in practice activities and never used in feedback. • Tapes are accurate in spelling, grammar, and word usage. • Packaging is not well designed for component parts. Cassette tapes consistently fall out of the loose-leaf binder when it is picked up. There is no way to keep them together except by repackaging them. • The writing style is appropriate for user population although there is very little prose. • Content is accurate and free of sexual, racial, and ethnic bias. • Design of the program is organized in a consistent fashion across different segments (i.e., the structure of the addition segment is parallel to the structure of the division segment). • No documentation of development and/or research is provided.
	SUMMARY This is a standard drill and practice program that clearly achieves its purpose--to act as a supplement to the classroom teaching and provide drill on basic arithmetic computations. One problem is that the range of content is quite limited, failing to cover a large part of the mathematics curriculum such as fractions, decimals, ratios, and measurement. Given that the program has such a narrow scope, it could probably be used as a successful supplement to any on-going basal arithmetic program, especially in the early grades. The supplementary <i>K-8 Cross-Reference Guide</i> is an excellent source to help the teacher integrate the program into the curriculum. The program uses some of the capabilities of the computer like immediate reinforcement; but, for the most part, it is a very non-creative approach to the microcomputer. There is no element of

excitement or fun in using this program with its endless frames of drill to be completed, very similar to a test. There is very little useful instruction and written directions for the student are virtually nonexistent. A major drawback is the rudimentary management system that makes it difficult for a teacher to track student progress. The vertical and horizontal sequences are also confusing to use. Much of the content overlaps but there is very little guidance on how to integrate Parts I and II in the Teacher's Manual.

Given its cost and narrow content range, this program may be useful to a classroom teacher who wishes to supplement the math curriculum with some computer drill and practice.

RECOMMENDATIONS

- Broaden the scope of the program to include other topics in the K-8 mathematics curriculum. As it stands now it is an arithmetic program.
- Include more specific activities and suggestions in the Teacher's Manual about how to use the program in the classroom, especially regarding integrating the horizontal and vertical sequences.
- Have instructions in the program for the student. Right now a lot of pre-teaching is needed before a student can begin.
- Borrowing is poor; the cursor is located above the regrouping position at the start of the problem. It is confusing for the student to know what to do and it gives away the answer.
- There should be a cue at the bottom of the screen to remind the student about pressing the "C" key for carrying and the "B" key for borrowing during a problem.
- The demonstration of exercises for younger grades go much too fast. A student should have control over viewing each step at his/her own pace.
- The "Wake up!" or "Try Harder!" after a response is threatening. Eliminate such comments and make the micro-computer friendly.
- If a wrong number is entered during a problem and a student presses the key to erase the error, the whole answer disappears and must be done over again. The student should be able to erase only one number at a time. In addition, that answer registers as a mistake, penalizing the student for trying to correct errors.
- Enter some element of fun and motivation into the program so it is more gamelike and enjoyable.

SRA Computer Drill and Instruction: Mathematics

Publisher: SCIENCE RESEARCH ASSOCIATES
155 North Wacker Drive
Chicago, Illinois 60606

Copyright: 1981

Microcomputer: Atari 800 (40K)
Apple II or Apple II Plus (48K) with 3.2.1 or 3.2 DOS

Cost: \$1225 (managed version)

Components:

GRADE LEVEL	TITLE	MEDIUM	TEACHER'S MANUAL
A (1,2)	Add A Les 1-26	1 disk	1 Teacher's Manual (same for entire program)
	Sub A Les 1-17	1 disk	
	WHN A-1 Les 1-21	1 disk	
	WHN A-2 Les 22-41	1 disk	
	Teacher Disk	1 disk	
	Student Disk	2 disks	
B (3,4)	Add B Les 1-21	1 disk	1 Teacher's Manual (same for entire program)
	Sub B Les 1-18	1 disk	
	Mul B Les 1-25	1 disk	
	Div B-1 Les 1-26	1 disk	
	Div B-2 Les 27-35	1 disk	
	FRA B-1 Les 1-14	1 disk	
	FRA B-2 Les 15-26	1 disk	
	WHN B Les 1-21	1 disk	
	Teacher Disk	1 disk	
	Student Disk	2 disks	
C (5,6)	Add C Les 1-13	1 disk	1 Teacher's Manual (same for entire program)
	Sub C Les 1-8	1 disk	
	Mul C Les 1-12	1 disk	
	Div C Les 1-30	1 disk	
	WHN C Les 1-16	1 disk	
	Fra C Les 1-21	1 disk	
	Dec C-1 Les 1-20	1 disk	
	Dec C-2 Les 21-42	1 disk	
	Dec C-3 Les 43-54	1 disk	
	Teacher Disk	1 disk	
	Student Disk	2 disks	

Subject Area: Mathematics

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Tutorial
Computation

Intended Users: As stated in the Teacher's Manual: grades 1-6, older students or adults wherever practice with arithmetic skills is needed.

Learner Entry Competencies: Basic processes in mathematical computations, but this is not specified in the Teacher's Manual.

INTENTS

Developer's Rationale: As stated in the Teacher's Manual: "By utilizing a personal computer, *SRA Computer Drill and Instruction: Mathematics* enables students to practice basic arithmetic skills and immediately find out how well they are doing. It also offers tutorial instruction that students can request as they need it. A management program is available to monitor and record each student's progress, continually diagnosing and delivering exercises at the appropriate level of difficulty."

Major emphasis of the rationale is to:

- Develop skills in a particular area;
- Supplement other resources;
- Provide a management system.

Learner Objectives: Appendix 1 of the Teacher's Manual contains all the mathematics objectives for the entire program. An example from Level A Addition is:

Lesson 4

Objective: Facts, sums to 9; horizontal; 0 allowed

Example: $4 + 5 = \underline{\quad}$

No. of exercises: 20

Major emphasis of objectives is:

- Recall of previously learned facts

Instructional Strategies:

- Objectives are listed though they are not stated behaviorally.
- Objectives are not stated in terms of the learner.
- Objectives predominately stress the skill of recall. The tutorial section does emphasize comprehension but there are few exercises that stress application, analysis, synthesis or evaluation.
- Learners are never informed of the objectives.

CONTENTS

Scope: Scope of the content material covers the following topics: addition, subtraction, multiplication, division, fractions, whole numbers (numeration, place value, ordering) and decimals.

- Range of the content material is adequate to achieve program's intents.
- Scope is appropriate for learning levels of intended users.

Sequence: The program is divided into three different levels: A for first and second grades, B for third and fourth grades, C for fifth and sixth grades. These levels determine which skills are taught and are carefully outlined in Appendix 1 in the Teacher's Manual. Within each topic, the program follows the conventional sequence of school mathematics. This sequence has been carefully analyzed into small steps that cover the content rather carefully and thoroughly. As a student progresses through the content and works his/her way through the lessons, the skills become increasingly more difficult.

The teacher initially places a student into a particular content area and assigns different topics for the student to do. The student must then take a placement test to determine an appropriate entry point into the content. Once placed, the student's sequence through the content is set by the program, which will branch the student up and down based upon performance. The student can always exit an activity by pressing escape and pursue a new assignment in a different topic. Upon reentry into a content area, the program will always return the student to the specific lesson he/she was working on.

Sequence of content is based upon:

- Natural units in the subject-matter;
- Task analysis (i.e., breaking each sequence into parts and teaching progressively harder steps).

Pre-Instructional Strategies:

- Pretests are always used; they are called Placement Tests in this program.
- Advanced organizers such as pre-questions, overviews, and summaries are never used, though the student is given an opportunity to do exercises before entering a lesson.
- A clear and concise title is always present at the beginning of each disk but is never present at the beginning of each segment or lesson.

Instructional Strategies:

- Information is formatted for easy reading although a few questions could be clearer.
- Labels or headings identify different kinds of information in the HELP sequence, but they are not used in the rest of the program.
- Sentence structure is easily understood for the user population.
- Vocabulary is appropriate for user population, though it might be difficult for the younger grades.
- When used, graphics are sometimes embedded in the instructional content (i.e., are an essential part of the instruction) and sometimes used for enhancement of feedback. Graphics are used especially in the optional HELP mode.

- Graphics are always used appropriately:
 - they are relevant for user's age and level;
 - they are not distracting;
 - they support the program's intents.
- Cues and/or prompts are never used after a wrong response.
- Action sometimes occurs on the screen. Graphic movement occurs in the HELP mode and in the grid at the bottom of the screen which counts how many exercises were answered correctly or incorrectly.
- A demonstration of the exercise is never given although HELP mode, which offers a detailed tutorial on how to do the exercise, is always available.

METHODOLOGY

Teacher/Student Use: The teacher initially places the student in the disk and then the program operates in placement mode to determine where the student should start. Once placed, the student works in a progress mode which automatically moves a student from lesson to lesson based upon a criterion score (80% or more moves the student ahead one lesson; 50-79% repeats the lesson; 49% or less moves the student down one lesson). There is also a practice mode that the student can work in which does not affect the student's standing.

To operate the managed version of this program requires using one disk drive and two or more disks for each session. The teacher has a Student Disk, content disk(s) and a Teacher Disk which must be inserted at the appropriate times in the program. The student must use the Student Disk and whatever content disks he/she is assigned. Though the instructions are quite clear as to when one disk should be taken out and another inserted, the methodology is cumbersome and needs quite a bit of training for teachers and students to utilize the program correctly. The Teacher Disk allows a teacher to see reports of the student's progress and the Student Disk is designed to manage the records of the teacher and his/her class.

Teacher Guidance: The basic methods for using the program are specified in the Teacher's Manual. The manual does provide technical assistance on how to use the program in the microcomputer and general suggestions to help the teacher. But the Teacher's Manual tends to be too general and does not give the teacher enough specific information to be able to operate the program independently. Some specific instructional activities are given to help integrate the program into the classroom environment. If a teacher sat down and read the Teacher's Manual from cover to cover before using the program, he/she might be able to operate the program. But with the quick perusal which is more likely to occur, a teacher will probably have difficulty. Though the instructions are clear and provide a step-by-step approach, they are not well organized and an index would be a very helpful addition. As the Teacher's Manual stands, it is inadequate and incomplete.

Instructional Strategies:

- There are almost no instructions for the student.
- The user can control:
 - rate that display material is presented in order to read information at his/her own pace;
 - choice of sequence so that the user is not confined to a linear path;
 - exiting an activity at any time;
 - options available in the sequence such as HELP, and keys for erasing, borrowing, carrying, and regrouping.

The user cannot control:

- amount of time allowed for solving the problem (i.e., the user cannot choose how many seconds each problem is presented);
- where entry into the program must begin;
- reviewing instructions.

MEANS OF EVALUATION

Management System/Tests: This program comes in two versions, managed and unmanaged. The managed version has a quite sophisticated management system, one of its greatest attributes. It allows a teacher to enter students' names into the program, have the computer automatically place each student into his/her appropriate level, track the students' progress through the content, prescribe appropriate activities based on performance, and keep permanent records on the disk for future use by the teacher. Though the managed version requires the teacher to use three or more disks at one time, it is well worth the effort it would take to learn how to use it. Five different reports are available to the teacher regarding student and class progress, all of which are thoroughly explained in the Teacher's Manual. Tests are included in the program; a placement test is always available, and due to the fact that this is a mastery program that sets criterion levels for advancement or failure, "testing" is continuous throughout. All records are kept secure from students with the use of a "password" which each student must choose when he/she initially enters the program. This may require the teacher to write down all passwords and keep track of them as there is no way to determine what one is once it has been entered.

Instructional Strategies:

- Feedback is used after both correct and incorrect responses.
- Feedback never explains why the response is wrong.
- Feedback always informs what the correct response is after the HELP keys are pressed.
- Feedback responses never vary from activity to activity. The HELP option does allow a user to get a tutorial for each exercise desired.

- Feedback always uses printed words and a graphic smiley face.
- Feedback is used appropriately:
 - it is non-threatening;
 - it is immediate;
 - it doesn't over-reinforce correct responses;
 - it remediates if desired with the HELP tutorial;
 - it doesn't reinforce wrong responses;
 - it is relevant for user's age and level.
- The management system uses percentile management (it keeps track of percentage correct and incorrect) and diagnostic management (it varies level of difficulty as a result of performance).
- Records are informative most of the time. There are so many of them (five in all) that some will be more useful than others. Only after using the records for a prolonged period of time can usefulness be determined.
- Records are not as easily accessible to the teacher as they could be. It requires using two disks and it takes some time before each record is accessed.
- Cumulative records for each student are stored on a magnetic disk for future retrieval.

INSTRUCTIONAL DESIGN CONGRUENCE

Congruence: This program shows excellent internal congruence with all four constructs being mutually supportive. This is a very tight drill and practice program.

USE CONSIDERATIONS

Technical Considerations:

- Graphics have clear resolution, are not in color, and are presented clearly for maximum understanding.
- An audio "beep" is an option available for feedback.
- Frame display is always clear of clutter, formatted for easy reading most of the time, and always cleared before each new display.
- Program content is not always technically easy to utilize in the computer due to the multi-disk method.
- Disks are accurate in spelling, grammar, and word usage.
- Packaging of the program is not well designed for component parts. The disks fall out when the notebook is held upside down. Furthermore, the Teacher and Student Disks are not labelled "A", "B", or "C" to differentiate between the levels; this could cause some unnecessary problems.
- The same Teacher's Manual comes with all three levels.
- The writing style is appropriate for the user population.

- The content is accurate and free of sexual, racial, or ethnic bias.
- Design of the program is organized in a consistent fashion across different segments (i.e., the addition disk is parallel to the structure of the decimal disk).
- No documentation of development and/or research is provided. No evidence of learner verification and revision is included.

SUMMARY

This is probably one of the better drill and practice math programs on the market to date. Although the three-disk management system is quite cumbersome to use, it offers a number of benefits to the teacher: a diagnostic placement test to determine a student's initial entry point; a prescriptive system to move a student up or down based upon performance; and a variety of record-keeping options. While the major part of this large program is devoted to an ordinary drill and practice routine, the opportunity to call for HELP is another strong, positive feature. The HELP option offers a tutorial during the progress and practice mode at any time a student desires and teaches each concept in small, progressively harder steps that are controlled by the student. These two features, a sophisticated management system and a tutorial option, make this a very attractive program.

However, there are a number of drawbacks to consider before investing in this program, and "investing" is the appropriate terminology when considering the price of the total managed program--\$1225. Much pre-teaching is also assumed before the program can be utilized correctly. Teachers will need a lot of training on how to use the three-disk management system effectively and efficiently. The student also will need many computer skills to use the program. First he/she has to learn how and when to remove the disks. There are also lessons that require the student to become oriented to two keys (-- and --) in order to move the cursor into the correct algorithmic position to erase errors. "Cursor backwards" erases the numbers in the same order they were placed on the screen, allowing a student to correct an answer. "Cursor forward" moves the cursor to a new position for regrouping, borrowing, etc. This requires a deft hand and quick mind on the part of the student while possibly interrupting the flow of practice. An orientation session for the student is a must in these instances.

Many of the higher-level problems such as addition and subtraction of fractions require that the student perform the operations on paper and then enter the answer on screen. This brings up the issue of whether problems of this sort should be drilled on the computer and whether the microcomputer is the appropriate medium to teach such higher-level, complex operations. A workbook might be just as efficient.

SRA Computer Drill and Instruction is a well-designed drill and practice program that offers a teacher many beneficial features. These positive features must be juxtaposed against the constraints and carefully considered. It is one of the first programs to extend the standard drill and practice into a more sophisticated tutorial.

RECOMMENDATIONS

- Make the Teacher's Manual easier to use by adding an index and organizing it under specific topics. The program requires a lot of pre-teaching and the Teacher's Manual could help to alleviate that problem. It is too brief at this point to really help; more detailed instructions are needed.
- There are some "bugs" in the disks at this time. In some lessons the cursor does not erase unless the key is depressed many times and in a few instances erasing does not work at all.
- If students get an answer wrong, they cannot get an immediate correct answer without going through the long HELP tutorial. At that time, their incorrect answer is long forgotten. There should be some immediate way to compare the wrong answer to the correct answer without going through the tutorial.
- Often the cursor position gives an answer away. In many problems, the cursor moves left after each number is entered. After the correct number of digits are entered, the cursor will not move any more and another number cannot be entered, clueing the student that the correct number of digits has been entered. During long division, the cursor locates itself in the correct position and tells the student where to start the quotient.
- The boxes at the bottom of the screen are used for counting the number of responses correct and incorrect in one lesson. Each time a problem is finished, all the boxes are removed from the screen and redrawn. When there are 20 problems in a lesson, all twenty boxes need to be redrawn each time a problem is completed, which becomes distracting and time-consuming. A better method would be to keep the boxes on the screen and just remove the exercise.
- After a response is complete, the student must press "return" twice to move on to the next exercise, once to register the response and once to move along to the next exercise. This is a definite deterrent throughout the program to smooth, flowing, and quick practice. The second "return" is probably unnecessary.
- Program packaging needs to be re-designed. The disks fall out of the notebook and Teacher Disks and Student Disks are not labelled according to "A", "B", or "C" levels.

SRA Fact Track

Publisher: S.R.A.
155 North Wacker Dr.
Chicago, IL 60604

Copyright: 1981

Microcomputer: Apple II, 48K
Atari 800, 32K

Cost: \$75.00

Components:

GRADE LEVEL	TITLE	MEDIUM	TEACHER'S GUIDE
elementary - adult	Fact Track	1 disk	1 Teacher's Guide

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice

Intended Users: Young children, older children, and adults who need practice in arithmetic facts, as specified in the materials.

Learner Entry Competencies: Basic competencies in the processes of computation are necessary, but this is not specified in the program.

INTENTS

Developer's Rationale: As stated in the Teacher's Guide: "The Fact Track program is a personal computer program designed to help students master the arithmetic facts."

- To develop skills in a particular area
- To supplement other resources

Learner Objectives: No specific objectives are stated in the Teacher's Guide but there is a page listing the contents of the program and these could become objectives. An example from the Addition sequence is as follows:

- Level 1: Sums 2 to 5; nonzero addends
- Level 2: Sums 0 to 9; emphasis on sums 6 to 9
- Level 3: Sums 0 to 12; emphasis on sums 10 to 12

Major emphasis of inferred objectives is:

- Recall of previously learned facts

Instructional Strategies: No distinct strategy using Intents is employed to facilitate learning.

- Objectives are not stated behaviorally.
- Objectives are not stated in terms of the learner.
- Objectives stress the skill of recall and rarely include the higher order skills such as comprehension, application, analysis, synthesis, and evaluation.
- Learners are never informed of the specific objectives.

CONTENTS

Scope: Scope of the content material covers: addition, subtraction, multiplication, division, mixed operations, and extensions (skills beyond facts such as multiplying by 10).

- Range of content material is adequate to achieve program's intents.
- Scope is appropriate for the learning levels of the intended users.

Sequence: As specified in the Teacher's Guide, a student will work through each sequence depending upon the level he/she is on. Within each sequence there are different levels of increasingly more difficult skills for the student to master.

The sequence from unit to unit can be determined by either the student or the teacher, but the sequence within each unit is determined only by the program. Once in a specific activity (e.g., Addition, Level 3), a student must complete that activity in a linear sequence and there is no way of exiting it once it is started. Upon completion of each activity, a student has three choices: to repeat the lesson, to do the problems he/she got incorrect, or to start over at the beginning of the program.

Sequence of content is based upon:

- Natural units in the subject matter
- Task analysis (i.e., breaking each sequence into parts and teaching progressively harder steps).

Pre-Instructional Strategies:

- Pretests are not used; initial placement into each sequence is made by the student or teacher.
- Advanced organizers such as pre-questions, overviews, and summaries are not used.
- A clear and concise title is presented at the beginning of the disk but no titles are given before each specific instructional sequence or problem level.

Instructional Strategies:

- Information is formatted for easy reading.
- Labels at the top of the screen are used to identify the segment and level a student will work on (i.e., "Addition Level 3").
- Short, concise sentences are used.
- The vocabulary is sometimes inappropriate for the user. At times words in the menu are too difficult for younger children.
- Graphics are used in two instances: 1) during a "race" between the user and the rocket, which is an optional mode;

and 2) when the computer gives a user problems every "x" seconds and graphically shows the user how many problems are left. They are never used as part of the instructional content, but for enhancement of feedback and content only.

- Graphics are not used appropriately:
 - the rocket is not relevant for older children and adults (though it is optional);
 - the graphics are often distracting from the content;
 - they never support the program's intents.
- Cues and/or prompts are never used.
- The only time any action other than words or numbers appears on the screen is during feedback when the rocket is used in a race against the user.
- A demonstration of the exercise is never given.

METHODOLOGY

Teacher/Student Use: According to the Teacher's Guide, a student "signs in" by typing his/her name; a menu is then displayed. The student is asked to select which group of facts to practice, which level he/she wishes to be on, and which skill he/she wishes to reinforce. Next the student is given another menu asking for the particular mode he/she wants to practice. Two of the modes are interactive, whereby the student types an answer, presses "Return" and gets another exercise. One of the options can be used by groups of students as well as individuals; 20 facts (or all the facts for one operation) are displayed, one at a time, at a rate that can be specified. After the problems are displayed, the computer shows what all the answers are. If an interactive mode is chosen, more options are given concerning the amount of seconds each problem is displayed, and the setting of a goal whereby the student can race a rocket. In the race there are two rockets. One moves at a speed determined by the student's actual performance and advances for correct answers. The other rocket moves at the speed determined by the student's goal. Once the activity is completed the student has three more options: to repeat the lesson, to start over, or to do the problems that were missed.

Although the Teacher's Guide specifies that a student must set up his/her own lesson, presumably a teacher may determine the options for younger students by initially placing the student in the correct sequence, choosing the appropriate level and skill, and selecting one of the modes. The variety of menus and options may be a bit overwhelming and difficult to manipulate for many students.

Teacher Guidance: Methods for using the materials are specified in the Teacher's Guide. The Teacher's Guide does provide enough information to familiarize a teacher with the technical use of the program. It contains a section "Using the FACT TRACK program in the Classroom"

where brief suggestions for integrating the program into the classroom are given.

There was disagreement among analysts over whether the instructions in the Teacher's Guide are well-organized and clearly stated. A few analysts felt that the directions are confusing and not stated as clearly as they could be. It does provide a step-by-step approach for the student but no student's manual is included. Teacher training is not mentioned.

Instructional Strategies:

- Instructions in the program for the student are not always easily understood. The option selection can be confusing for young children as they are supposed to set up the program themselves.
 - Some user control is available to the student in the total program. If the student sets up his/her own options, he/she will have control over:
 - the amount of time allowed for solving the problem;
 - the rate at which the display material is presented so the user can read information at his/her own pace;
 - choice of sequence so that user is not confined to a linear path;
 - where entry into the program will be.
- The user has no control over:
- exiting an activity at any time;
 - reviewing instructions;
 - options available in the sequence itself such as pressing "HELP", "HINT", or "ESCAPE" keys.

If the teacher sets up the options for the student, the user can control only the three options available at the end of each lesson and has no control over the program itself.

MEANS OF EVALUATION

Management System/Tests: A management system is not included in this program nor are any tests. A record form and answer sheet are included in the Teacher's Guide but records of students' progress are not stored in the computer's memory.

Instructional Strategies:

- Feedback is used after both correct and incorrect responses.
- Feedback never explains why the response is wrong.
- After the lesson is completed, the correct answer is displayed for all those problems that were answered incorrectly.
- Feedback responses never vary from activity to activity or within each activity. "GOOD" and "WRONG" are the only responses shown.

● Feedback sometimes uses a graphic rocket which is optional; feedback always uses printed words. ● Feedback is used appropriately some of the times: - it is non-threatening; - it doesn't over-reinforce correct answers; - it doesn't reinforce wrong responses; - it is appropriate for user's age and level. - Feedback is used inappropriately at times: - It is NOT immediate; correct answers are displayed at the completion of a sequence; - it does NOT remediate. ● The management system does not store any information. ● Cumulative records for each student can be stored on printed sheets found in the Teacher's Guide by copying the responses off the computer.	been provided.
INSTRUCTIONAL DESIGN CONGRUENCE <u>Congruence:</u> Since no management system is included in the program, there is no means of evaluation and therefore internal congruence is lacking. If one considers the whole program as a test, and if successful completion of the drill exercises constitutes evaluation, then there is congruence.	SUMMARY This program achieves what it sets out to do: to provide a lot of practice in the number facts. It does not attempt to provide instruction; basically it functions as a good example of a drill and practice program. The lack of a management system is a major drawback. The teacher has no accessible record of student progress on the computer and must trust a student to copy student records after each run of the program or find the time to copy them himself/herself. And even though the Teacher's Guide claims that the program can be used to diagnose the difficulty students are having with specific facts, no real diagnostic information is provided. The graphics are considered to be very distracting. The rocket is not used effectively because eye focus had to alternate between the keyboard to press the appropriate keys, and on the screen where the number facts are displayed - not on the rocket. This problem is particularly acute due to the timing factor of the race against the rocket. It becomes impossible to concentrate on all three at once, and so is best to ignore the rocket. In addition, the use of graphics to keep track of the number of questions in an activity is a bit distracting. Considering the amount of memory needed to construct such graphics, it was felt that the graphics could be used in a more purposeful fashion to enhance or support the instructional intent. Another problem may arise with trying to have younger children arrange their own options and work their way through the program alone. Many of the menus may be difficult for children to understand. Though the Teacher's Guide stipulates that students should set up their own lessons, alternate arrangements should be considered, with the teacher choosing most of the options. Fact Track contains a highly structured design that carries over from unit to unit. This structure is well suited to the overall purpose of the program, practicing facts. In its role as a drill and practice program that reinforces basic arithmetic facts taught in the classroom, it is quite a good presentation.
USE CONSIDERATIONS <u>Technical Considerations:</u> ● Graphics, when used, have clear resolution, are not in color, and are presented clearly. ● Frame display is clear of clutter, formatted for easy reading, and cleared before each new display. ● The program is not always technically easy to utilize in the computer. It is too difficult for younger children and often takes too long to load and reload. ● Random generation is always used in practice activities and never used in feedback. ● The program is accurate in spelling, grammar, and word usage. ● Packaging is well-designed for component parts and contains a Teacher's Guide. ● The writing style is not always appropriate for younger children as the menu is too hard. ● Content is accurate, free of sexual, racial, and ethnic bias. ● Design of the program is organized in a consistent fashion across different segments (i.e., the structure of the addition segment is parallel to other segments in the program). <u>Development:</u> ● No documentation of development and/or research has been provided. No evidence of learner verification and revision has	RECOMMENDATIONS ● Revise the use of the graphics so that they support or enhance the instructional intent and thereby are used in a more purposeful fashion. ● Too much time is needed to go from one activity to another. It seems to take an unusually long time for various portions of the program to load and reload. Perhaps this could be corrected through reprogramming.

- No immediate corrective feedback is given after wrong responses; rather, once the activity is completed, all correct answers are shown. Feedback is most effective when it is immediate.
- The Teacher's Guide caused some confusion when it was going step-by-step through the various options. It was not clear whether to read across the rows or down the columns. More elaborate suggestions on how to integrate the program into the classroom could be included.
- There should be some way for a student to get out of the lesson if he/she decides not to do all the problems.
- If a student is to set up the lesson him/herself, including a student guide with specific instructions would be very helpful.
- The added component of a management system which stores student records in the computer's memory would be very helpful and would give this program tight internal congruence.

Microprocessor Games

THE EDUCATIONAL IMPACT AND POTENTIAL OF MICROPROCESSOR GAMES: A FIELD STUDY

INTRODUCTION

When microprocessor games are designed with arithmetic problems to solve or words to spell, instead of invaders to shoot down, are they "educational"? Might they be useful in classrooms? Especially for their hypothesized motivational effects in classrooms with disadvantaged students?

EPIE Institute, in its role as educational consumer advocate, and the Ford Foundation, in its concern about the impact of microprocessor games in education, agreed that "educational" microprocessor games was a market worth investigating. Funding from the Ford Foundation supported EPIE's study of the set of eight games (five math and three spelling and facts games) categorized in a *Consumer Reports* article as "educational." Students in four schools with heavy Title I populations on Long Island and in New York City were observed using the games. Teachers, students, and teacher-aide/parents were interviewed as an attitude measure of the games' educational efficacy. Pre- and post-tests were administered to see whether a statistically significant gain in math and spelling proficiency could be measured for students using the games.

The formal results of the study were inconclusive; no significant gain in math or spelling proficiency was measured for users of the games. Informally, however, several interesting findings can be reported, the most important being a clarification of the term "educational" as applied to these games.

Also clarified, as a result of the experimental design, is the age-appropriateness of each of the games' subgames. Manufacturers' age recommendations are for entire games, regardless of the range and variation in a game's subgames. These recommendations are both too general ("ages 5 and up," "age 6 to adult") and, it was found, frequently inaccurate.

Most telling, of the informal results, are the teachers' attitudes toward having these games in their classrooms.

THE GAMES TESTED

The eight microprocessor games tested were provided to EPIE by Consumer Reports, serial number identification still taped to the cases. The same games that Consumer Reports had tested with staff members' children, EPIE took into the public school classrooms where the children had never seen any of the games before.

The games reviewed represent a sampling of the many similar games available. Consumer Reports listed no criteria for including these particular games, and they perhaps represent the most widely advertised and/or most widely purchased of this category of microprocessor games.

Most of these materials are designed with more than one game/learning task available. These learning tasks are referred to as "subgames" and each has been tested independently. Subgames were categorized and a panel of educators created an ease/difficulty rating which was then assigned to each subgame. The purpose of this rating is to allow consumers to see that a game recommended by its manufacturer for "ages 5 and up" might have only one, if any, of its several subgames (each contributing to the price of the game) that a five-year old could work at. Table 1 below lists the eight microprocessor games and their subgames, each with an ease/difficulty rating of from 1 to 7, 1 being easiest. Math games range from 1 to 4 while spelling and facts games range from 1 to 7.

THE STUDY DESIGN

Because of the practical considerations of working with children in a school setting, EPIE categorized the participants by grade level rather than age level, assuming an acceptable correspondence between grade and age when kindergarten represents age five, first grade represents age six, and second grade represents age seven. (All the microprocessor games are recommended by their manufacturers as

SUBGAME CATEGORIES		#"ages 7 and up"	#"ages 5 and up"	#"ages 5 and up"	#"ages 5 and up"	#"ages 5 and over"
	MATH GAMES	DATAMAN	MATH MASTER	LIL GENIUS	LITTLE PROFESSOR	QUIZ KID
	Add, Subtract, Multiply, Divide	*1	*1	*1	*1	*1
	Solve Algebraic Equations	*2	*2			
	Complete Multiplication Table Equations	*3, *3	*3			
	Miscellaneous	*4, *4				
		#"ages 6 and up"	#"ages 7 and up"	#"ages 6 to adult"	KEY: # Manufacturer's Age Recommendation * EPIE Ease/Difficulty Rating	
	SPELLING AND FACTS GAMES	SPELLING B	SPEAK & SPELL	QUIZ WIZ		
	Auditory/Visual Spelling (Direct Spelling)	*4	*4			
	Letter Supplying (Indirect Spelling)	*6, *5, *3	*6			
	Unscramble Words	*7				
	Decoding		*7			
	Sound Out From Visual Display		*4			
	Equivalent to Television Viewing		*1			
	Spelling and Facts			*indeterminate		

Table 1. A Comparison of Manufacturers' Age Recommendations and EPIE Ease/Difficulty Ratings

appropriate from age five, six, or seven.) EPIE also included students in grades three through seven to signal at what grade/age level the more difficult subgames become appropriate.

Pre- and post-tests were administered to participants in both math and spelling. The TORQUE mathematics tests were used to obtain baseline data against which to compare later student performance on identical computations ($4 + 3$ TORQUE and $4 + 3$ subgame) and generically similar computations ($11 - 10$ TORQUE and $19 - 16$ subgame) on one or more subgames. Spelling pre- and post-tests were administered orally.

In addition to measuring the games' effect on student performance, this study sought to measure teacher, student, and parent attitudes toward the games in general and to determine what made a game desirable to children given a variation among games of the stimulus feature (game displays a problem or player creates) and the reinforcement feature (visual, auditory, or combination).

FINDINGS

The mathematics games correlate (if at all) with too few grade-level curricula to be "cost-effective" below fifth grade with Title I students. The functions presented (or to be entered by the player) by all the five games, and by all their collective 12 subgames, are reducible to the four basic operations - adding, subtracting, multiplying, and dividing.

The best predictor of game performance was previous mastery (TORQUE performance being its measure). The only evidence to the contrary was due to differences in presentation formats:

Particularly among the lowest age range for whom games were recommended (ages 5-7, occasionally 8), if a problem was presented vertically on the TORQUE:
e.g., $\begin{array}{r} 6 \\ +3 \\ \hline \end{array}$ or, $\begin{array}{r} 9 \\ -2 \\ \hline \end{array}$ and then (necessarily due to

constraints on the games' display panels) horizontally:

e.g., $6 + 3 = \underline{\quad}$ or, $9 - 2 = \underline{\quad}$, the youngest students almost invariably failed to answer correctly after correctly answering the identical item on the TORQUE.

The youngest students (and even some as old as 9 and 10) were unable to cope with any multiplication or division equations.

In the case of the spelling games (SPEAK AND SPELL and SPELLING B, respectively designated by their manufacturers as appropriately sold for use by age-groups "7 and up" and "6 and up"), EPIE found summarily:

(1) Neither served as an instructional device, properly speaking: students either knew or did not know how to spell the words. Those who did know appeared to find the positive "beep" of reinforcement encouraging, but clearly became bored rather quickly. Students, on the other hand, who did not know, did not, without exception, learn the correct spelling even after two-to-three repetitions and were, additionally, bored when not frustrated.

When a word-to-be-spelled was presented orally, students at least had the advantage of spelling the right word. When the word-to-be-spelled was represented visually by a line drawing, one fact emerged and several things happened:

a) Only nouns can be presented.
b) Even at that, many of the line drawings are of insufficient definition - some are capable of multiple interpretations - to allow unequivocal identification. That fact caused the phenomenon of some students spelling correctly the "wrong" word.

(2) Children of age seven (in the case of SPEAK AND SPELL and of age six in the case of SPELLING B) were one-to-two years younger in each case than the age where students could spell correctly even two-to-three

STIMULUS	DATAMAN						MATH MASTER			LIL GENIUS	LITTLE PROFESSOR	QUIZ KID	SPELLING B					SPEAK & SPELL					QUIZ WIZ
	D1	D2	D3	D4	D5	D6	M1	M2	M3				SB1	SB2	SB3	SB4	SB5	SS1	SS2	SS3	SS4	SS5	
Cue Provided		X		X	X		X	X	X		X		X	X	X	X		X	X	X	X	X	X
Cue Created By Player	X		X			X				X		X					X						
No Display										X		X											
Visual Display	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X			X
Auditory and Visual Display																		X			X	X	
REINFORCEMENT																							
Number of Tries Allowed	2	*	2	2	*	#	1-2	1-2	1-2	1	3	1	2	*	5	2	2	1	*	NA	1	NA	3
Display Gives Answer After 1 or More Tries	X	X	X	X	X	X	X	X	X		X		X	NA	X	X	X		NA	NA		NA	
Display Gives Cumulative Score	X	X	X	X	X	NA	X	X	X		X				X		X	X	NA	NA		X	

Table 2. Stimulus and Reinforcement Characteristics of the Games Tested

KEY: * Unlimited Tries

Function of Play

words in the games' displays. And there was no apparent reason why SPELLING B would be appropriate for children a year younger than those who could use SPEAK AND SPELL.

In the case of the Facts game, QUIZ WIZ, success depends entirely on familiarity with the field (sports, popular music, etc.). In fact, rather young students bested their teachers, teacher aides, and principals on questions regarding "TV."

The actual "instructional" function of these games was found to be nil. Given that the games will not teach what is not known, would they still have a place in the classroom as a highly motivating way to have students drill and practice the day's lesson or review a previous lesson? How attractive to teachers and students really were these games?

Students had absolutely no familiarity with these games when they were brought into their classrooms. However, when asked whether they liked the games and whether they would like to have the games, they unanimously side yes. "Will you leave the box of games?" students asked expectantly in every class. When students began to play the games, however, patterns of preference did emerge and boredom and frustration with some of the games became serious enough in some instances to require repeated bathroom passes and in one case a trip to the nurse. (The games with no display lost the students' interest after only one or two tryouts.)

Like the children Consumer Reports observed, these students preferred those games that provided the most stimulus and the most reinforcement. Children did not care to be able to create their own equations or games. When presented with such a situation, the children invariably worried and asked for instruction. "What should I put in here, sir?" became a familiar refrain.

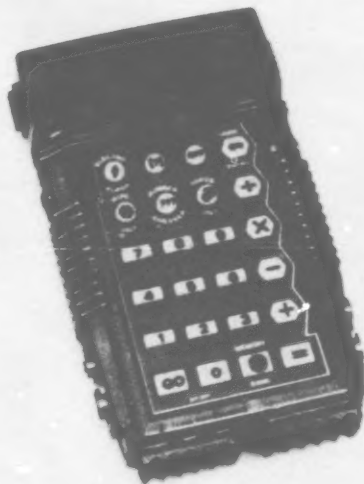
Students overwhelmingly preferred DATAMAN and SPEAK AND SPELL, the two games with the most sophisticated display and reinforcement capabilities.

Teachers' attitudes toward the games initially were accepting, with the expectation not that the games would be instructional,

but that they would be motivational. The resistance teachers feel toward having calculators in the classroom (before students have mastered their own calculating abilities) did not apply to the games. After observing the games in their classrooms, however, the teachers all concluded that they would not be particularly useful in a resource corner where one or two children at a time could have access to them. To be effective, teachers thought the games should be provided in large proportion equal to the students in the classroom - one game for every two students at the least. The expense of doing so, of course, the teachers considered folly. Teachers also scoffed at the idea of using the games in place of their basic textbook programs. The games were universally seen as supplementary materials with a rather limited role. Below the fourth or fifth grade, much of the games' contents reinforce or review what no one has yet learned.

In summary, these games were found to be educational only in the sense of reviewing or reinforcing what is already known. Given their limited contents, they are not cost effective below fourth or fifth grade even for review. Their motivational effects have not been proven, but a correspondence between interest in manipulating and mastering the game-as-toy and interest in performing the game tasks, as indicated with the least complex of the games, suggests that familiarity with the workings of a game might be accompanied by boredom with the medium and thus the tasks. Finally, and perhaps surprisingly, the teachers who observed these games in their classrooms do not feel that having one or two games in a resource corner would be particularly productive. The teachers do not think purchasing the games for all students is economically justifiable and they are not interested in having the games serve a reward function, i.e., "When you have finished your work you may go in the corner and play with the game."

Dataman



BASIC INFORMATION

<u>Manufacturer:</u>	Texas Instruments
<u>Price:</u> *	\$22
<u>Manufacturer's</u>	
<u>Age Recommendation:</u>	"Ages 7 and up"
<u>Number of Subgames:</u>	Seven
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	12-month
<u>General Description:</u> **	"You can create your own equations and answer them. Dataman's digital display gives you an 'atomic light show' if your answer is right or E-E-E and an angry barrage of flashes if it's wrong. After two tries, the display gives the correct answer. When you've done ten problems, Dataman tells you how many you answered correctly and presents another light show."

<u>Digital Display:</u>	Problem or equation displayed
<u>Feedback:</u>	Visual: light show or angry barrage correct answer after two tries cumulative score after 10 problems
<u>Quizbook:</u>	Instructions for special game keys, extra games
<u>Keyboard:</u>	0-9 + - x ÷ = Off, On, Go Memory Bank, Electro Flash, Wipe Out, Number Guesser, Force Out, Missing Number

SUBGAMES

<u>Subgame Category:</u>	Add, Subtract, Multiply, Divide
<u>Description:</u>	Memory bank stores ten problems
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:***</u>	1
<u>Cue Information:</u>	Created by player
<u>Special Feature:</u>	Displays cumulative time taken to answer set of ten problems

*** The math games tested range in ease level from 1-4, with 1 being easiest. Spelling and facts games tested range from 1-7 in ease level.

DATAMAN SUBGAMES (cont)

Subgame Category: Solve Algebraic Equations

Description: "Other keys provide...problems with missing factors"

Number of Players: One

EPIE Ease Rating:*** 2

Cue Information: Provided

Special Features: Missing factor may be moved to either side of equal sign
Player may choose from two difficulty levels

Subgame Category: Complete Multiplication Table Equations (1)

Description: "You can create your own equations and answer them"

Number of Players: One

EPIE Ease Rating:*** 3

Cue Information: Player creates

Subgame Category: Complete Multiplication Table Equations (2)

Description: "Other keys provide multiplication tables"

Number of Players: One

EPIE Ease Rating:*** 3

Cue Information: Provided

Subgame Category: Miscellaneous Tasks/Operations (1)

Description: "Number Guesser puts a mystery number (between 9 and 100) into Dataman's memory and gives clues to help figure out the number. When the player guesses the number, the display tells how many tries it took."

Number of Players: One

EPIE Ease Rating:*** 4

Cue Information: Provided

Number of Tries: Until correct

Subgame Category: Miscellaneous Tasks/Operations (2)

Description: "Force Out and Wide Out are games for two or more players; Dataman is passed around until someone is 'out,' rather like the schoolyard game of hot potato."

Number of Players: Two or more

EPIE Ease Rating:*** 4

Cue Information: Provided

Number of Tries: Varies with each round

Math Master



BASIC INFORMATION

Manufacturer:	Epoch
Price:*	\$32
Manufacturer's Age Recommendations:	"Ages 5 and up"
Number of Subgames:	Three
Batteries Required:	Two "AA"
Warranty:	12-month
General Description:	"It offers problems at two levels of difficulty. The game can be operated in two modes...automatic mode gives you the right answer after you've given two wrong answers. In manual mode, you have to punch a key to get the answer. At the end of 10 problems, the display shows the number answered correctly on the first try, and the number answered correctly on the second (or further) try."

Digital Display:

Equation provided with missing answer;
correct answer only displays

Feedback:

Visual: EE instead of wrong answer
correct answer after two tries
(unless in Manual mode)
cumulative score after 10 problems
(number of problems, number correct
first try, number correct second try
or eventually)

Quizbook:

None

Keyboard:

0-9
+ - x ÷
Answer
C (clear)
A - M (Automatic or Manual)
L1, L2, L3, L4 (two levels of difficulty
only)

UBGAMES

Subgame Category:	Add, Subtract, Multiply, Divide
Description:	Player chooses problem sets in either of two levels of difficulty in any of the four functions
Number of Players:	One
EPIE Ease Rating:***	1
Cue Information:	Provided
Special Feature:	Two levels of difficulty

* Price quotes are for relative comparisons only

** *Consumer Reports*, November 1979, pp. 638-640

*** The math games tested range in ease level from 1-4, with 1 being
easiest. Spelling and facts games tested range from 1-7 in ease
level.

MATH MASTER SUBGAMES (cont)

Subgame Category:	Solve Algebraic Equations
Description:	"Another option is problems presented in algebraic format, where you fill in a missing number on the left side of the equals sign.
Number of Players:	One
EPIE Ease Rating:***	2
Cue Information:	Provided

Subgame Category:	Complete Multiplication-Table Equations
Description:	"A third option is multiplication tables."
Number of Players:	One
EPIE Ease Rating:***	3
Cue Information:	Provided

Lil Genius



BASIC INFORMATION

<u>Manufacturer:</u>	Coleco
<u>Price:*</u>	\$10
<u>Manufacturer's</u>	
<u>Age Recommendation:</u>	"Ages 5 and up"
<u>Number of Subgames:</u>	One
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	None
<u>General Description:**</u>	"...Lil Genius has...one red and one green eye. When you punch in a problem and answer, the green eye flashes if you're right, or the red eye...and a buzzer...tell you you're wrong. You can enter problems in addition, subtraction, multiplication, or division...You have to push

three keys to find out if your answer is correct. Hit those keys in the wrong sequence, and the red light and buzzer go off....you can't look at a problem again to see what went wrong...."

<u>Digital Display:</u>	None
<u>Feedback:</u>	Visual and audio: green light if correct red light and buzzer if incorrect
<u>Quizbook:</u>	Games to play with math facts
<u>Keyboard:</u>	0-9 + - x ÷ = decimal point C (clear) PLS (please), CHK (check), ?! (answer)

GAME

<u>Subgame Category:</u>	Add, Subtract, Multiply, Divide
<u>Description:</u>	Answer checker with no display
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:***</u>	1
<u>Cue Information:</u>	None

* Price quotes are for relative comparisons only
 ** *Consumer Reports*, November 1979, pp. 638-640
 *** The math games tested range in ease level from 1-4, with 1 being easiest. Spelling and facts games tested range from 1-7 in ease level.

Little Professor



BASIC INFORMATION

<u>Manufacturer:</u>	Texas Instruments
<u>Price:</u> *	\$15
<u>Manufacturer's Age Recommendation:</u>	"Ages 5 and up"
<u>Number of Subgames:</u>	One
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	12-month
<u>General Description:</u>	"...is similar to Math Master. It has a digital display. You don't create your own equations... it tests you in addition, subtraction, multiplication, and division."

<u>Digital Display:</u>	Equation provided with missing answer, correct answer only displays
<u>Feedback:</u>	Visual: EEE if wrong correct answer after three tries cumulative score after 10 problems
<u>Quizbook:</u>	Games to play with math facts, level coded
<u>Keyboard:</u>	0-9 + - x ÷ = Off, On, Go Set, Level

GAME

<u>Subgame Category:</u>	Add, Subtract, Multiply, Divide
<u>Description:</u>	Player chooses one of four functions, one of four difficulty levels, and answers set of ten problems
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:</u> ***	1
<u>Cue Information:</u>	Provided
<u>Special Feature:</u>	Player may choose from four difficulty levels

- * Price quotes are for relative comparisons only
 ** *Consumer Reports*, November 1979, pp. 638-640
 *** The math games tested range in ease level from 1-4, with 1 being easiest. Spelling and facts games tested range from 1-7 in ease level.

Quiz Kid



BASIC DESCRIPTION

<u>Manufacturer:</u>	National Semiconductor
<u>Price:*</u>	\$10
<u>Manufacturer's Age Recommendation:</u>	"Ages 5 and over"
<u>Number of Subgames:</u>	One
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	3-month
<u>General Description:**</u>	"...owl's face with one red and one green eye. When you punch in a problem and answer, the green eye flashes if you're right, or the red eye tells you you're wrong. You can enter problems in addition, subtraction, multiplication, or division...Quiz Kid needs only one key to get results...you can't look at a problem again to see what went wrong if the red light appears."

<u>Digital Display:</u>	None
<u>Feedback:</u>	Visual: green light if correct red light if incorrect
<u>Quizbook:</u>	Games to play with math facts
<u>Keyboard:</u>	0-9 + - x ÷ = decimal point C (clear) ? (check answer)

GAME

<u>Subgame Category:</u>	Add, Subtract, Multiply, Divide
<u>Description:</u>	Answer checker
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:***</u>	1
<u>Cue Information:</u>	None

- * Price quotes are for relative comparisons only
- ** *Consumer Reports*, November 1979, pp. 638-640
- *** The math games tested range in ease level from 1-4, with 1 being the easiest. Spelling and facts games range from 1-7 in ease level.

Speak and Spell



BASIC INFORMATION

<u>Manufacturer:</u>	Texas Instruments
<u>Price:</u> *	\$55
<u>Manufacturer's Age Recommendation:</u>	"Ages 7 and up"
<u>Number of Subgames:</u>	Five
<u>Batteries Required:</u>	Four "C"
<u>Warranty:</u>	12-month
<u>General Description:</u>	"In the basic game, the voice tells you to spell a word. As you spell it out on an alphabet keyboard, the voice repeats the letters pushed. After you press ENTER, the voice lavishes praise if you're right or says some variation of 'try again' if you're wrong. At the end of each game, the display and voice tell you the score."

<u>Digital Display:</u>	Letters appear on screen and voice spells them out
<u>Feedback:</u>	Visual and audio: voice congratulates or consoles cumulative scores both audio and visual
<u>Quizbook:</u>	Instructions for special game keys, extra games
<u>Keyboard:</u>	Alphabet A,B,C,D (levels of difficulty) On, Go, Enter, Repeat, Erase, Replay Say It
<u>Additional Modules Available:</u>	Vocabulary

SUBGAMES

<u>Subgame Category:</u>	Auditory/Visual Spelling (Direct Spelling)
<u>Description:</u>	A simulated human voice pronounces a word for player to spell on keyboard and repeats the letters pushed
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:</u> ***	4
<u>Cue Information:</u>	Provided
<u>Special Feature:</u>	Four difficulty levels to choose from

* Price quotes are for relative comparisons only

** *Consumer Reports*, November 1979, pp. 638-640

*** Spelling and facts games tested range in ease level from 1-7, with 1 being the easiest. Math games tested range from 1-4 in ease level.

SPEAK AND SPELL SUBGAMES (cont)

Subgame Category: Letter Supplying (Indirect Spelling)

Description: "'Mystery Word' is like the paper and pencil game of 'Hangman.' The display shows dashes for the number of letters in the secret word. The player hits letter keys until he or she guesses the word."

Number of Players: One

EPIE Ease Rating:*** 6

Cue Information: Provided

Subgame Category: Decoding

Description: "'Secret Code' codes and decodes words by alphabetic substitution."

Number of Players: One

EPIE Ease Rating:*** 7

Cue Information: Provided

Subgame Category: Sound Out from a Visual Display

Description: "...the display shows a word and the voice says, 'Say it.' Then the voice pronounces the word."

Number of Players: One

EPIE Ease Rating:*** 2

Cue Information: Provided

Subgame Category: Equivalent to Television Viewing

Description: "'Letter' simply displays and pronounces randomly selected letters."

Number of Players: One

EPIE Ease Rating:*** 1

Cue Information: Provided

SPELLING B SUBGAMES (cont)

Subgame Category: Letter-Supplying (Indirect Spelling)
Description: Mystery Word...a version of "Hangman"
Number of Players: One
EPIE Ease Rating:*** 6
Cue Information: Provided
Special Feature: Three levels of difficulty

Description: Missing Letter...dashes on the display indicate missing letters for the player to fill in.
Number of Players: One
EPIE Ease Rating:*** 5
Cue Information: Provided
Special Feature: Three levels of difficulty

Description: Starts With...player guesses first letter of each word
Number of Players: One
EPIE Ease Rating:*** 3
Cue Information: Provided
Special Feature: Three levels of difficulty

Subgame Category: Unscramble Words (Spelling Know-How Assumed)
Description: "Scramble is for two players. One of them puts up to five words in the computer. The words reappear one at a time for the second player to unscramble."
Number of Players: Two
EPIE Ease Rating:*** 7
Cue Information: Players create

Quiz Wiz



BASIC INFORMATION

<u>Manufacturer:</u>	Coleco
<u>Price:</u> *	\$25
<u>Manufacturer's Age Recommendation:</u>	"Ages 6 to adult"
<u>Number of Subgames:</u>	One
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	3-month
<u>General Description:</u>	"This is a multiple-choice game...comes with a quiz booklet and an answer cartridge containing 1001 questions and answers on a variety of subjects...enter the number of any question and push answer key A,B,C, or D. If you're right, you get a beep and a green light. If you're wrong, a buzz sounds and a red light

goes on. If you want to try again, you have to clear the machine and re-enter the question number and another answer. You have to clear the machine between each question too."

Digital Display:

None

Feedback:

Visual: green light if correct
red light if incorrect
Audio: buzz if incorrect

Quizbook:

Question booklet

Keyboard:

0-9
A,B,C,D
Answer, Clear

Additional

Cartridges Available: \$7 each*

GAME (CARTRIDGE #1)

Description:

Categories have from eight to 98 questions. Largest categories are music (popular), TV, travel, movies, history, synonyms and antonyms, science. 116 questions specified for children 6-10.

Number of Players:

One

EPIE Ease Rating:***

Variable from category to category

Cue Information:

Provided

- * Price quotes are for relative comparisons only
- ** *Consumer Reports*, November 1979, p. 638-640
- *** Spelling and facts games tested range in ease level from 1-7, with 1 being easiest. This game was not rated, however.

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Spelling B



BASIC INFORMATION

<u>Manufacturer:</u>	Texas Instruments
<u>Price:</u> *	\$30
<u>Manufacturer's Age Recommendation:</u>	"Ages 6 and up"
<u>Number of Subgames:</u>	Five
<u>Battery Required:</u>	9-volt
<u>Warranty:</u>	12-month
<u>General Description:</u> **	"A picture book comes with this spelling game. When you push GO, a number appears on the display. You turn to that number in the booklet and spell out on the game's keyboard the name of the object pictured. A correct spelling puts RIGHT on the display. An incorrect spelling displays WRONG, and you get a second chance. If you're wrong again, the machine spells the

word correctly and goes on to the next word. Each quiz of five words follows the pictures consecutively so you don't have to keep flipping pages in the book. Spelling B has a 264-word vocabulary.

Digital Display:

Feedback:

Quizbook:

Keyboard:

Letters appear on screen

Visual: "Right" or "You Win" if correct
"Wrong" if incorrect

Pictured nouns to spell

Alphabet

Off, On, Go, Enter, Erase, Clue, Memory
Level (1-3)

Starts With, Missing Letter, Mystery Word,
Scramble

SUBGAMES

<u>Subgame Category:</u>	Auditory/Visual Spelling (Direct Spelling)
<u>Description:</u>	Number displayed on keyboard is keyed to picture book. Player spells keyed word. Five consecutive numbers make a set, for which player's score is displayed.
<u>Number of Players:</u>	One
<u>EPIE Ease Rating:</u> ***	4
<u>Cue Information:</u>	Provided
<u>Special Feature:</u>	Three levels of difficulty to choose from

* Price quotes are for relative comparisons only

** *Consumer Reports*, November 1979, pp. 638-640

*** Spelling and Facts games tested range in ease level from 1-7, with 1 being easiest. Math games tested range from 1-4 in ease level.